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NATURAL HISTORY
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STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION

THEODORE H. FRISON, *Chief*

BULLETIN

OF THE

Illinois State Natural History Survey

URBANA, ILLINOIS, U. S. A.

Vol. XIX

CONTENTS AND INDEX

1930-1932



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STATE NATURAL HISTORY SURVEY DIVISION

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CONTENTS

ARTICLE I. THE FISHES OF CHAMPAIGN COUNTY. By DAVID H. THOMPSON AND FRANCIS D. HUNT. (6 text figures, 52 maps) September, 1930		1-101
Introduction		5
Description of the area.....		5
Description of the streams.....		7
Methods and equipment.....		14
List of species, with analytical keys and data on distribution and abundance		17
Type habitats		34
Abundance and number of kinds.....		39
Relation of distribution and abundance to stream size.....		41
Headwater fishes		47
Relation of soil fertility to growth and abundance of fishes.....		48
Effects of pollution on growth, distribution and abundance of fishes		50
Other environmental factors affecting distribution and abundance..		58
Effect of fish-eating species on abundance.....		58
Some observations on morphological adaptations.....		58
Migration, isolation and changes in distribution.....		60
Association of species.....		66
Summary		70
Distribution maps		71
Appendix		98
Index to names of species.....		99
ARTICLE II. RECORDS OF SPRING MIGRATION OF BIRDS AT URBANA, ILLINOIS, 1903-1922. By FRANK SMITH. October, 1930		105-117
Historical		105
Areas in which records were made.....		106
General considerations		108
Lists of recorded species and varieties.....		109
Literature cited		112
Migration record of species.....		113
ARTICLE III. THE PLANT LICE, OR APHIIDAE, OF ILLINOIS. By FREDERICK C. HOTTES AND THEODORE H. FRISON. (10 plates, 50 text figures) September, 1931.....		121-447
PART I		
Introduction		123
Limitations		126
Acknowledgments		127
Structure		128
Life histories		130
Distribution		135
Cyrus Thomas collection.....		140
Designations of types.....		141
Collection and preservation of material.....		144
Applied control		145
Natural control and interrelations.....		147

ARTICLE III. THE PLANT LICE, OR APHIIDAE, OF ILLINOIS.

BY FREDERICK C. HOTTES AND THEODORE H. FRISON.—CONT'D

PART II

Family Aphidae (with key to subfamilies).....	148
Subfamily Aphinae (with key to supertribes).....	149
Supertribe Lachnea (with key to genera).....	150
Genus Anoecia	151
Genus Cinara	153
Genus Eulachnus	157
Genus Longistigma	157
Genus Tuberolachnus	159
Supertribe Chaitophorea (with key to genera).....	160
Genus Amphiceridus	160
Genus Chaitophorus	160
Genus Clavigerus	165
Genus Gypsoaphis	167
Genus Paducia	167
Genus Periphyllus	170
Genus Plocamaphis	172
Genus Siphia	174
Supertribe Aphiea (with key to genera).....	175
Genus Alphitoaphis	175
Genus Aphis	176
Genus Asiphonaphis	225
Genus Brachycolus	228
Genus Brevicoryne	228
Genus Cavariella	229
Genus Cerosipha	229
Genus Hyalopterus	231
Genus Hysteroneura	232
Genus Rhopalosiphum	234
Genus Toxoptera	241
Supertribe Callipterea (with key to genera).....	242
Genus Calaphis	243
Genus Cepegillettea	246
Genus Drepanaphis	246
Genus Euceraphis	249
Genus Iziphya	250
Genus Melanocallis	251
Genus Monellia	252
Genus Myzocallis	254
Genus Neosymydobius	261
Genus Phyllaphis	264
Genus Saltusaphis	265
Genus Shenahweum	267
Genus Stegophylla	268
Genus Tamalia	268
Genus Thripsaphis	270
Genus Tuberculatus	271

PART II—CONT'D

Family Aphidae—cont'd

Subfamily Aphiinae—cont'd

Supertribe Macrosiphea (with key to genera).....	273
Genus Amphorophora	273
Genus Capitophorus	280
Genus Idiopterus	292
Genus Macrosiphum	293
Genus Microparsus	333
Genus Myzus	334
Genus Pentalonia	345
Genus Phorodon	345

Subfamily Eriosomatinae	345
-------------------------------	-----

Supertribe Eriosomea (with key to genera).....	345
Genus Asiphum	348
Genus Colopha	348
Genus Eriosoma	350
Genus Forda	354
Genus Geoica	356
Genus Georgiaphis	357
Genus Gobaishia	359
Genus Melaphis	359
Genus Mordwilkoja	360
Genus Neoprociphilus	361
Genus Pemphigus	363
Genus Prociphilus	370
Genus Thecabius	374
Genus Trifidaphis	374

Subfamily Mindarinae	374
----------------------------	-----

Supertribe Mindarea	374
Genus Mindarus	374

Subfamily Hormaphidinae	375
-------------------------------	-----

Supertribe Hormaphea (with key to genera).....	375
Genus Hamamelistes	375
Genus Hormaphis	376

PART III

Keys to species of plant lice grouped with reference to host plants..	378
Apple	378
Berries	379
Garden flowers	379
Grain crops	381
Greenhouse plants	382
Legumes	383
Ornamental shrubs	384
Peach, plum, or cultivated cherry.....	387
Truck crops	387
Vines	388
Host index	389
Bibliography	404
Plates	418
Addenda	438
Index	439

ARTICLE IV. THE PLANKTON OF SOME SINK HOLE PONDS IN SOUTHERN ILLINOIS. By SAMUEL EDDY. (1 map) Septem- ber, 1931		449-467
Introduction		449
Perennial ponds		451
Temporary ponds in old sink holes		455
Relation of sink hole ponds to springs.....		457
Conclusions		457
Bibliography		459
ARTICLE V. THE PLANKTON OF THE SANGAMON RIVER IN THE SUMMER OF 1929. By SAMUEL EDDY. January, 1932.....		469-486
The plankton of the Sangamon river in the summer of 1929.....		469
Bibliography		477
Tables I-IV		478-486
ARTICLE VI. AN EXPERIMENTAL AND OBSERVATIONAL STUDY OF THE CHINCH BUG IN RELATION TO CLIMATE AND WEATHER. By V. E. SHELFORD. (37 text figures) January, 1932		487-547
Introduction		487
Equipment and operation.....		488
Length of instars and the life history.....		489
Methods and results.....		490
Table I. Approximately constant temperature.....		491
Table II. Variable temperature.....		495
Individual variation		497
Effect of humidity.....		498
Table III. Humidity differences.....		499
Table IV. Simulation of daily march of temperature and rel- ative humidity		501
Table V. Combined velocity values.....		503
Table VI. Length of life cycle.....		503
Velocity curves and charts.....		504
Table VII. Cultural conditions		505
Developmental totals		513
Overwintering		515
The cultures		515
Vigor of stock.....		519
Effect of light.....		521
Abundance in nature.....		531
History in Illinois.....		531
Weather relations		533
Conclusion		545
Bibliography		546
INDEX		549
ERRATA		555

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THEODORE H. FRISON, *Acting Chief*

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Article I.

The Fishes of Champaign County

A Study of the Distribution and Abundance
of Fishes in Small Streams

BY

DAVID H. THOMPSON

and

FRANCIS D. HUNT



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TABLE OF CONTENTS

Introduction	5
Description of the area	5
Description of the streams.....	7
Methods and equipment.....	14
List of species, with analytical keys and data on distribution and abundance	17
Type habitats	34
Abundance and number of kinds.....	39
Relation of distribution and abundance to stream size.....	41
Headwater fishes	47
Relation of soil fertility to growth and abundance of fishes.....	48
Effects of pollution on growth, distribution, and abundance of fishes.....	50
Other environmental factors affecting distribution and abundance.....	58
Effect of fish-eating species on abundance.....	58
Some observations on morphological adaptations.....	58
Migration, isolation, and changes in distribution.....	60
Association of species.....	66
Summary	70
Distribution maps	71
Appendix	98
Index to names of species.....	99

THE FISHES OF CHAMPAIGN COUNTY*

A Study of the Distribution and Abundance of Fishes in Small Streams

DAVID H. THOMPSON AND FRANCIS D. HUNT

A careful account of the local and general distribution of the fishes of Illinois, their relations to their environment, and the function and relative importance of each species in the general system of aquatic life, was presented twenty years ago in a comprehensive work by Forbes and Richardson¹, which was based primarily on a state-wide ichthyological survey. In the present study the general methods employed in the former survey have been applied intensively to a small area, Champaign County, and use has been made of special methods which yield results more strictly quantitative. Inasmuch as there exist among the small stream systems of this county faunal differences comparable to those found among large stream systems, not only in Illinois but elsewhere as well, the intensive study of this restricted area has made it possible to formulate in a more precise manner some of the general conclusions previously reached by other workers on the distribution and abundance of fishes. The use of quantitative methods of collecting has made it possible also to arrive at new conclusions based on such data as may have passed unnoticed in a less detailed study or in streams too large to apply such methods.

DESCRIPTION OF THE AREA

Champaign County is located in the east-central part of Illinois and is crossed by the 88th meridian and the 40th parallel. Measuring approximately 36 miles from north to south and 27.5 miles from east to west, the county has an area of 988 square miles. The topography varies from flat to slightly rolling land, the variations being due to two causes—glacial action and stream erosion. The average altitude is about 710 feet above sea level; a maximum of 860 feet is reached on the Champaign moraine and a minimum of 630 feet where the Salt Fork leaves the county.

*This study was carried on and completed under the direction of the late Stephen Alfred Forbes.

1. Forbes, S. A., and R. E. Richardson. "The Fishes of Illinois." Final Reports of the Illinois Natural History Survey, Vol. III, 1909.

During the Glacial Period, Champaign County was covered by two ice sheets, the Illinoian and the Early Wisconsin; and the otherwise monotonous topography of the county is broken by their terminal moraines, which commonly rise 50 to 100 feet above the intermorainal tracts, vary from one-half mile to three or four miles in width, and usually form the boundaries between the several drainage basins (Fig. 1). As the Early Wisconsin sheet receded, the various parts of the county were uncovered in the following order: first, the lower part of the

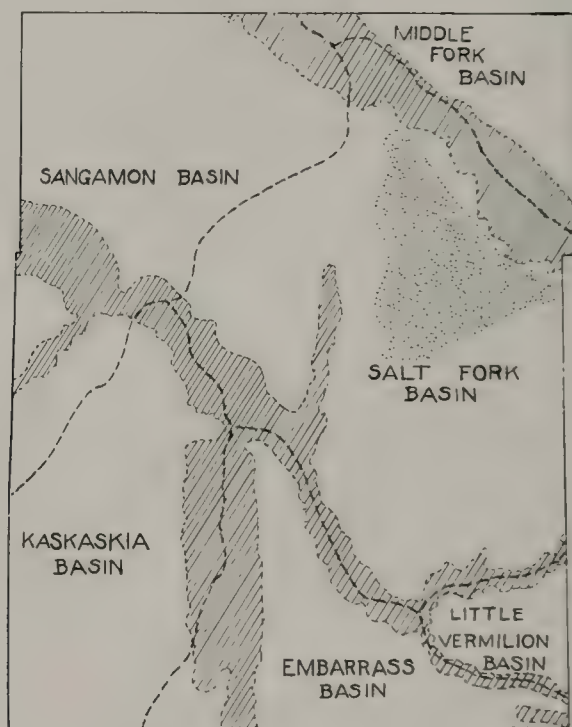


Fig. 1. Sketch map of Champaign County, showing watersheds (dotted lines), glacial moraines (cross-hatching), and unusually fertile area (stippling).

Sangamon basin; next, the Kaskaskia and Embarrass basins; then the upper Sangamon, Salt Fork, and Little Vermilion basins; and lastly, the basin of the Middle Fork of the Vermilion. The general aspects of the topography now are the same as at that time, and there has been no subsequent change in the hook-up of the drainage systems.² There are no outcrops of rock in the county, as it is covered with a layer of boulder clay ranging from 95 to 300 feet in thickness.³

2. Personal communication from Dr. M. M. Leighton, Chief, Illinois State Geological Survey.

3. Ill. Agr. Exp. Sta. Soil Report No. 18, "Champaign County Soils," 1918.

The soils of Champaign County are fertile and, taken as a whole, are more uniform than those of other counties of the state. Dark upland prairie soils make up 92 percent of the area of the county, and upland timber soils an additional 5 percent. Of the 92 percent of upland prairie soils, 73 is brown silt loam and 18 is black clay loam. Almost all of the upland timber soil is yellow-gray silt loam. The water-table in the county lies 45 to 60 inches beneath the surface and is generally more uniform in depth than in other counties.⁴

There is an area of about 50 square miles in the eastern part of the county in which the soil has a different history from that of the rest of the county and is unusually fertile. This area is drained by the East Branch of the Salt Fork and lies north of the town of St. Joseph. (See Figure 1.) The soil of this area was formed under water, and until this part of Illinois was settled, it was a marsh in which water-fowl abounded. Later, when ditches were dug, the marsh was reduced to a few ponds, and more recently it has been drained completely, but the organic matter that had accumulated under water has not leached away. The soil is highly calcareous and therefore rich in available plant foods; nodules of calcium carbonate occur throughout it and render it more alkaline than other soils of the county. An unusually rich fish fauna was found in the streams of this area, as will be shown in a later section.

Weather records for the past 26 years have been kept by an observer of the United States Weather Bureau at Urbana. The Weather Bureau station is near the center of the county and has an altitude of 743 feet. The mean annual temperature for the 26 years is 51.2° F. and the mean annual rainfall 34.26 inches. The mean temperature for 1928 alone was 51.4° F. and the total rainfall 32.96 inches.

The mean monthly temperatures for 1928 and for the past 26 years are as follows:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1928	27.5	32.2	39.6	46.8	61.8	65.4	74.8	74.0	61.8	57.2	42.4	33.4
Ave. 26 yrs.	25.9	27.7	40.2	50.4	61.0	70.3	74.7	72.9	66.2	54.1	41.7	29.3

The mean monthly rainfalls for 1928 and for the past 26 years are as follows:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1928	2.18	2.28	1.45	3.16	2.48	4.65	3.59	2.77	3.65	2.34	1.88	2.53
Ave. 26 yrs.	2.12	1.78	3.38	3.74	3.94	3.16	3.01	3.44	2.98	2.38	2.13	2.20

DESCRIPTION OF THE STREAMS

Six streams have their headwaters in Champaign County: the Sangamon River, the Salt Fork and the Middle Fork of the Vermilion River, the Embarrass (pronounced Ambraw), the Kaskaskia (otherwise known as the Okaw), and the little Vermilion. The headwaters of

4. Personal communication from Mr. E. A. Norton, Assistant Chief, Soil Survey.

these six streams interlace except as they are separated by glacial moraines (see Figure 1). The drainage area in square miles at the point where each stream leaves the county is as follows: Sangamon 388, Salt Fork 307, Middle Fork 241, Embarrass 106, Kaskaskia 98, and Little



Fig. 2. Sketch map of Illinois, showing the location of Champaign County with respect to stream systems. The dotted line indicates the boundary of the unusually fertile area discussed in the text (page 50).

Vermilion 28. Other small streams flow out of the county, but they soon join one or the other of these six larger ones. The relation of these headwater streams to the larger streams of Illinois is shown in Figure 2.

While fishes in the headwaters of the Salt Fork may be but 2 or 3 miles overland from fishes in the headwaters of the Sangamon, they are more than 1,200 miles apart by water.

Because of the essential flatness of the county, most of the smaller streams have been straightened and deepened by dredging. This dredging has tended toward greater uniformity of environment but has not changed appreciably the kinds of fishes present nor their general distribution within the streams. However, dredging has an effect on the minutiae of their distribution and, less obviously, on their abundance. The cycle of change may be summed up as follows:

A brook meanders across a pasture with alternate gravelly riffles and vegetation-bordered stretches of mud and sand; is slowed down as it enters pools about the roots of trees in a patch of woodland; or is



Fig. 3. View of Sangamon River near Mahomet.

scattered into a dozen channels as it passes through a bit of marsh choked with willows and cat-tails. Thus the stream is well differentiated into a variety of situations, each with its own characteristic fishes. A dredging machine goes past and we have, instead, our brook flowing along a deep groove in the earth, with dirt piled in a high ridge on each side, of uniform width and grade, and uniformly denuded of every shred of vegetation. There are no more riffles, no shaded pools, but only constantly flowing silt-laden water. Now, for a few weeks or months, our fishes become literally the "mere ghosts" of their former selves. Owing to the lack of light they all fade to a uniform paleness. Since their food is destroyed, their bellies shrink, and their heads assume

a prominence disproportionate to their customary aspect. But soon the process of redifferentiation begins. Gravelly riffles begin to form, with long stretches of sluggish water between. A few rains scoop out deep holes where the channel is narrowed by bridge abutments. Small drifts of debris furnish cover for fishes that seek it, and offer a richer spot for the beginnings of rooted vegetation than naked glacial till. In a year or two we see a heavy growth of weeds on the banks of the ditch and overhanging the water. A little later a sprinkling of willow and cottonwood appears, and in the water a fringe of *Elodea*, water cress, water smartweed, *Myriophyllum*, and many other coarse aquatic plants. At the end of 20 or 30 years we find that our brook is again something like its former self. It has gravelly riffles, meanders back and forth within its narrow confines, is choked by dense beds of aquatic plants.



Fig. 4. View of Kaskaskia River near Bondville.

At some places it is open to the sky, but at others it is thickly overhung by an ever-crowding thicket of willows and other small trees. Deep, shaded pools are also found about the roots of these newly grown trees. The vegetation checks the flow of water; the ditch fills up with silt from the fields; and then the dredging machine comes plodding up the stream again.

Dredge ditches showing this cycle of change are numerous in the county, and examples of all the different stages can be found within a single stream system such as the Kaskaskia. When the fishes of an old ditch are compared with the fishes of a new ditch, no outstanding difference is seen except that certain vegetation-loving forms, such as the pirate-perch and the grass pike, are temporarily absent in the new

ditch. As for the rest of the fishes, we get about the same numbers and about the same proportion of the different species.

The slope of headwater streams in the county is commonly 10 to 15 feet per mile. Farther downstream the usual slope is 3 to 5 feet per mile. While the slope of one stream may be somewhat greater than that of another of the same size, the result is not to produce new kinds of aquatic environment but only to vary the proportion of uniform riffles and uniform sluggish reaches. The three larger undredged streams of the county, the Sangamon, the Middle Fork, and the Salt Fork, are very similar and offer to fishes almost exactly the same variety of habitats.

The kind of bottom which a stream has in Champaign County is primarily a function of the rate of flow of the water. The stream



Fig. 5. View of Camp Creek near Seymour.

channels are cut in glacial till, which is made up of particles of many sizes, from clay whose particles are 0.0002 inch or less in diameter up to boulders 2 feet across. Owing to the sorting power of water, nothing but rocks and boulders will be found in the swiftest water; pebbles and rocks on ordinary riffles; gravel and sand in smoothly flowing stretches; while the silt and clay is carried along and dropped in deep, wide places and eddies and wherever the movement of the water is checked. The kind of bottom determines very largely the kind and amount of food organisms for fishes and is thus an important factor in their distribution. While rate of flow and kind of bottom are closely related causally, more fishes seem to distribute themselves more of the time according to current than according to kind of bottom.

Both direct and indirect evidence has been accumulated which shows that in streams of the same size there occur parallel variations in physical characteristics, such as temperature, dissolved oxygen, hydrogen-ion concentration, turbidity, ice conditions, flood conditions, kind of bottom, depth, vegetation, and available fish food.

Permanency of flow is a factor of prime importance to the fishes of small streams. The point above which a stream is reduced to a series of shrunken pools in dry weather varies from 2 to 10 square miles of drainage area, depending on the lay of the land, kind of soil, drainage improvements, etc.

Stream size, in this paper, has been expressed in square miles of drainage area. A calculation based on the average annual rainfall, as measured by the U. S. Weather Bureau at Urbana, and on the average run-off of various county streams, as measured by Mr. R. A. Norton, engineer of the U. S. Department of Agriculture, gives an average annual flow of almost exactly one cubic foot per second per square mile. This may be used as a rule of thumb to translate statements of drainage area (square miles) directly into terms of average annual flow (cubic feet per second), since the two are numerically equivalent. From the point of view of this paper a precise statement of the average annual flow of the various streams would be valueless because it represents a stage of water which is attained only occasionally as a stream is rising to, or receding from, a flood. The actual flow for all but a very small fraction of the total time is either more or less than the annual average.

Pollution by sewage, which is one of the most important factors affecting the variety and abundance of fishes in certain streams of the county, will be discussed separately (pp. 50-57).

The oxygen content of unpolluted streams in Champaign County varies from about 6 parts per million up to super-saturation due to the production of oxygen by chlorophyll-bearing plants in sunlight.

The pH varies from 6.5 to 8.3, with most readings between 7.2 and 7.8.

The turbidity, naturally, is extreme during freshets; but during ordinary or low stages of water, small objects on the bottom commonly can be seen through a foot of water in winter and 3 to 6 inches in summer, the comparative clearness in winter probably being due in part to the inactivity of the fishes and the lesser development of the plankton. The clearest stream in the county is the most heavily polluted part of the Salt Fork, and its clearness is probably due to the almost complete absence of fishes. Accurate measurements of turbidity were made at the beginning of this study but were soon discontinued because in many cases the roiliness was directly traced to ditching machines, bridge building, livestock wading in the water, and other temporary disturbances.

Temperatures in local streams vary from freezing in winter to 90°F. in unshaded stretches in mid-summer, although the variations, of course, are not quite so abrupt nor so great as in the air. Most fishes are sedentary and do not feed or grow much when the water is at or near the freezing point. The growing season for most of the local fishes is probably about seven months—from sometime in March or early April until October or early November. Usually for a month during every

winter, the streams are completely frozen over except for the riffles, and on the more slowly moving stretches ice may form to a thickness of 12 or more inches. In summer, there is great variation in the temperature of the water at different places in the streams, depending on the amount of shade.

The Middle Fork, the Salt Fork, and the Sangamon, before leaving the county, form narrow flood plains which may reach a quarter-mile or more in width. At ordinary or low stages of water each of these streams flows between steep earth banks, 4 to 8 feet below the flood plain, but at least once each year the water rises 10 or 15 feet and covers the flood plain.

The common coarse aquatic plants of the county have been observed, and specimens have been identified by Mr. L. R. Tehon, Botanist for the Illinois Natural History Survey. A list follows:

Cladophora glomerata—streamers attached to stones of riffles and rapids of the larger streams.

Cladophora crispata—forming mats in quieter water of streams and ponds.

Fissidens Julianus—moss. On top of submerged rocks in the swiftest water of the Middle Fork and Sangamon.

Equisetum hiemale—horse tail. On ditch banks, etc.

Typha latifolia—common cat tail. In mud and shallow water at the headwaters of small streams.

Sparganium sp.—bur reed. In mud and shallow water along small streams.

Potamogeton americanus, *P. heterophyllus*, *P. zosterifolius*, and *P. pusillus*—Submerged in small flowing streams.

Sagittaria heterophylla—arrow leaf. Muddy banks of streams.

Elodea canadensis—In small flowing streams.

Grasses and sedges of various species. In and along streams.

Scirpus validus, *S. fluviatilis*, and *S. atrovirens*—bull rushes. In and along streams.

Lemna minor—duck weed. Floating and on muddy margins.

Spiradela polyrrhiza—duck weed. Floating and on muddy margins.

Juncus spp.—rushes. On muddy banks of streams.

Salix spp.—willows. Along streams of all sizes.

Rumex crispus—common dock. In or near the water in many situations.

Rumex verticillatus—swamp dock. In swampy places.

Polygonum Hydropiper—water smartweed. Abundant in sluggishly flowing streams and ditches of small size.

Nymphaea advena—yellow water lily. In sluggishly flowing pools.

Ranunculus aquatilis—butter cup. Muddy banks.

Radicula Nasturtium-aquaticum—water cress. Small flowing streams.

Callitriche sp.—water starwort. Small flowing streams.

Jussiaea diffusa—primrose-willow.

Myriophyllum heterophyllum—squirrel tail. Shallow water and muddy banks of small streams.

Dianthera americana—water willow. Gravelly and rocky shallows and shores of small swift rivers.

Cephalanthus occidentalis—button bush. Swampy flats along the larger streams the county.

Ambrosia trifida—giant ragweed. Fertile banks and flood plains.

Bidens frondosa, *B. cernua*, and *B. spp.*—Spanish needles, beggar's ticks. Along streams.

METHODS AND EQUIPMENT

In planning this quantitative study of Champaign County fishes it was foreseen that the important sources of error would likely arise in the collection of the fishes and the distribution of the samples. As has been stated before, all of these streams are small, with depths ranging from an inch to 3 feet at ordinary stages of water. Most kinds of fishing apparatus are highly selective and particularly so if any movement or other reaction of the fishes is necessary for their capture. It was decided that a single piece of fishing apparatus would give most uniform results, and for this a "common-sense" minnow seine was chosen, 10 feet long and 4 feet wide, with meshes $1\frac{1}{6}$ inch square. Of the 132 collections 127 were made with this seine, and the other 5 with an inch-mesh seine, 75 by 6 feet, which took only larger fishes. In subsequent treatment of the data the collections made with the latter seine were properly weighted and made to apply only to the larger fishes. Several years of experience with small seines in many kinds of situations, as well as continual estimation and measurement of the area covered per haul, indicated that in such small streams, with the same persons fishing in the same manner, a 10-foot minnow seine took fishes efficiently from 10 square yards, a 12-foot minnow seine from 15 square yards, and a 30-foot minnow seine from 50 square yards. The 75-foot inch-mesh seine used was estimated to include 100 square yards. The $1\frac{1}{6}$ -inch mesh used in this study took fry of the smallest sizes identifiable.

Another factor of great importance in making such quantitative studies of fishes is the skill and efficiency with which the equipment is used. The success of this phase of our work is due to the ingenuity and skill of the junior author in gathering up, not a few of the fishes, but almost all of them from a given area. Without someone who, through long experience, is thus able to collect fishes from the different situations efficiently, it would be practically useless to attempt quantitative work.

The collections are distributed over all the seasons of 1928 from early spring to late autumn, and for this reason the data not only present the average of a year's collecting but also indicate many instances of changes in detailed distribution of species.

While an attempt was made to do the collecting at ordinary stages of water, it nevertheless happened that the collections in some streams were made at higher stages and, hence, at considerably greater dilutions than in others which were abnormally low. The order of the stream systems according to their average stages of water when the collections were made, from greatest dilution to greatest concentration, is as follows: (1) Embarrass, (2) Kaskaskia, (3) Salt Fork, (4) Little Vermilion, (5) Sangamon, (6) Middle Fork. Differences in number of fishes per unit area due to differences in dilution may be as much as 50 to 75 per cent between the extremes, that is, between the Embarrass and the Middle Fork stream systems.

An effort was made to make collections as closely as possible proportional to water area. The following tabulation shows the number of collections and the total area collected over in streams of different sizes:

Stream size in square miles of drainage area	Number of collections	Total area of collections in square yards
½-1	5	140
1-2	5	97
2-4	7	345
4-8	21	985
8-16	22	1230
16-32	15	938
32-64	19	1670
64-128	12	1325
128-256	13	1360
256-512	13	1450

While smaller streams were sampled at intervals of 5 to 10 miles, larger streams were sampled every 1 or 2 miles. Collecting points were marked on our field maps in the laboratory prior to the actual collecting. We did not travel about over the country until we found a likely spot and then stop and fish. When a collecting point was reached our attention was directed primarily to making a composite collection representing proportionally, as far as possible, the various aquatic situations presented.

Two to four men made up the field party and travelled to and from the laboratory by automobile. The work was much facilitated by the large amount of paved highway in this county.

Since most of the collections were made near bridges, the locations were recorded by township, range, and section numbers as well as by name of stream and distance and direction from the nearest town, so that it will be possible to duplicate the sampling in the future if it is found desirable. Accession numbers were entered on the field map, which was a Soil Survey map cut into 12 pieces and mounted on pages in the field notebook.

The drainage areas of the various streams at each of the 132 points of collection were determined by marking out the drainage areas on U. S. Geological Survey and Illinois Soil Survey maps and measuring with a planimeter. While it is possible to express stream size as average annual flow in cubic feet per second, it has been thought best to leave it in square miles of drainage area (see above, p. 12).

The 132 quantitative collections of fishes made within the county in 1928 included 28,905 specimens, an average of some 220 fishes per collection. The area included in individual collections varied from 10 to 250 square yards, but 82% of the collections were made in areas of

more than 40 square yards. Before statistical treatment of the data was begun, all collections were reduced to numbers per 100 square yards.

One of the reasons for doing this intensive work was to permit a direct comparison with earlier collections made in Champaign County. This county was collected over at that time as thoroughly as any other part of the state, with collections distributed as follows: 1 in 1882, 3 in 1885, 1 in 1892, 2 in 1898, 22 in 1899, 3 in 1900, and 8 in 1901. The distribution of both recent and older collections by stream systems is as follows:

Stream system	Square miles of drainage area in the county	Number of collections	
		1882-1901	1923
Salt Fork	346	24	52
Sangamon	227	8	32
Embarrass	138	3	20
Kaskaskia	168	2	15
Middle Fork	69	3	9
Little Vermilion	40	0	4
Total	988	40	132

The net most generally used was treated for preservation with a light coat of pine tar, which was applied by diluting the tar with an equal amount of acetone.

Two or three square 5-gallon malted-milk cans with a 5-inch opening were used for storing collections temporarily in a strong formaldehyde solution. The fishes were dumped directly from the net into a 14-quart pail about half-full of strong formaldehyde solution, in which they died with the fins extended, the mouth and gills closed, and the body straight, making excellent specimens. The formaldehyde kills and hardens them so quickly that scarcely a scale is lost or a fin tattered, and the contour of the body is not in the least distorted. The latter fact is important because the confusion in the identification of certain groups, such as the genera *Carpiodes* and *Ictiobus*, seems to be due primarily to distortion in preserved specimens. Miscellaneous small bottom animals were thrown into the pail with the fishes and taken to the automobile or boat, where all were transferred to a bag made of a good quality of cheese cloth and measuring 12 by 17 inches. In order to avoid getting the formaldehyde on our hands, the transfer of the fishes, *etc.*, from the pail to the bag was made by putting the empty bag into the malted-milk can with the mouth of the bag lapped back over the lip of the can and fastened with a cord or a heavy rubber band. The bucket was emptied into the mouth of the bag, a slip of paper dropped in with an accession number corresponding to a page number in the loose-leaf field notebook, the mouth of the bag tied, and the whole stored in strong formaldehyde in a can of the kind described above. All the fishes collected were preserved except about a thousand which were

large and offered no difficulty in identification and which were returned to the water. Notes made in the loose-leaf field book were removed daily, and later typed in triplicate, as is our regular procedure for field notes. The laboratory identifications were entered on the back of each page of the notes.

Within a day or two after the collections were made they were sorted and identified in the laboratory by the junior author and checked by the senior author. Mr. R. E. Richardson kindly checked many doubtful specimens and all of several doubtful and variable species. His help in this respect lends confidence in comparisons to be made with earlier collections which he identified. At the present time there is an unidentified residue of only 2 or 3 juvenile specimens.

The data were tabulated on large sheets of co-ordinate paper with half-inch squares. Across the top of each table were column headings for accession number, location, date, drainage area, depth, width, rate of flow, kind of bottom, submerged non-living cover (such as brush, logs, debris, *etc.*), aquatic vegetation, shade, turbidity, temperature, the factor used to reduce actual numbers of fishes taken to numbers per 100 square yards, and finally the names of the 74 species of county fishes. In these columns were tabulated the field data and numbers of each kind of fish in each collection. The collections were arranged in the order of their upstream-downstream occurrence in each stream. In the columns under the names of the fishes, the actual numbers taken and the calculated numbers per 100 square yards were entered. Horizontal and vertical totals were made and checked against each other. These tables were then used as the basis for all subsequent calculations and are preserved in the files of the Illinois Natural History Survey.

LIST OF SPECIES, WITH ANALYTICAL KEYS AND DATA ON DISTRIBUTION AND ABUNDANCE

The following list of the species of fishes taken in Champaign County is presented especially for the use of collectors in this area. For the sake of conformity the scientific names and the general arrangement are the same as in "The Fishes of Illinois" by Forbes and Richardson (1909) except that some of the common names have been changed to conform with local usage. An appendix (page 98) lists those Champaign County fishes which have revised names in Jordan's "Manual of the Vertebrate Animals of the Northeastern United States" 13th edition, 1929. Notes have been added in some cases for the convenience of the collector.

The data shown here are based on 132 quantitative collections made in 1928 which included 28,905 specimens, with the addition of three species (*Ictiobus bubalus*, *Hybopsis storerianus*, and *Etheostoma jessiae*) represented by single specimens taken in the earlier collections of the Illinois Natural History Survey, and two other readily recognized large species (*Anguilla chrysypa* and *Leptops olivaris*) taken by anglers in 1928.

The habitat numbers refer to an ecological classification of Champaign County streams and fishes which follows (pages 34-39). Several habitat numbers following the name of a species indicate that it occurs most frequently in the first habitat, and so on, with its least frequent occurrence in the last habitat. Maps are appended showing the local distribution of all species represented by ten or more specimens in the collections of 1928. An explanation of these maps is given on page 71.

The distribution of a species is described as "restricted" when it is absent from one or more of the stream systems in which its preferred habitat or habitats generally occur. In labelling certain species as "restricted," it has been necessary to take into account the number of specimens collected, since by random sampling it is within the realm of probability that a few specimens of a rare species may be taken in one stream system and not in others in which they may nevertheless occur. The word "restricted" used in connection with these species implies a spotty distribution and a high degree of isolation.

The following analytical keys to the Champaign County fishes have been adapted directly from the Forbes and Richardson keys, but a few minor modifications have been made, mostly within the family *Catostomidae*.

KEY TO THE FAMILIES OF CHAMPAIGN COUNTY FISHES

- a Dorsal fin with no spines, or with only 1. Pelvic fin without spine.
 - b Head naked.
 - c Body scaled (scales small and obscure in the eel). Head without barbels or with not more than 2 or 4.
 - d Gill membranes free from the isthmus, i. e., split far forward and meeting in an acute angle.
 - e Lateral line present. (Moon-eye)..... **Hiodontidae**
 - ee Lateral line wanting. Last rays of dorsal fin much elongated. (Gizzard-shad) **Dorosomidae**
 - dd Gill membranes more or less broadly joined to the isthmus, not meeting in an acute angle.
 - f Pelvic fins wanting. Body eel-shaped. (Eel)..... **Anguillidae**
 - ff Pelvic fins present. Body not eel-shaped.
 - g Pharyngeal teeth numerous and comb-like. Mouth fitted for sucking. Lips more or less thick and plicate or papillose. (Suckers)..... **Catostomidae**
 - gg Pharyngeal teeth fewer than 8 on each side. Lips thin and never plicate or papillose. Dorsal fin of not more than 10 rays. (Minnows)..... **Cyprinidae**
 - cc Body and head naked. Eight long barbels about the mouth. (Catfishes) **Siluridae**
 - bb Head scaled. Body completely scaled.
 - h Lateral line present. Front of head shaped like a duck's bill. (Pike) **Esocidae**
 - hh Lateral line wanting. Mouth small and upturned. (Top-minnow) **Poecilidae**

- aa Dorsal fin with more than one spine. Pelvic fin with a spine.
 - i Insertion of pelvic fins distinctly nearer the anal fin than the throat. First dorsal separated from the second and composed of 4 weak spines. (Silverside).....**Atherinidae**
 - ii Insertion of pelvic fins distinctly nearer the throat than the first soft ray of the anal.
 - j Vent in front of pectorals. (Pirate-perch).....**Aphredoderidae**
 - jj Vent normal.
 - k Anal spines 3 to 10. (Sunfishes).....**Centrarchidae**
 - kk Anal spines one or two.
 - l Lateral line not extending onto the rays of the caudal fin. (Darters)**Percidae**
 - ll Lateral line extending onto the rays of the caudal fin. (Sheepshead)**Sciaenidae**

Family HIODONTIDAE—The Moon-eyes

Hiodon tergisus—Moon-eye; toothed herring.
1 coll. 1 spm. Habitat 9.

Family DOROSOMIDAE—The Gizzard-shad

Dorosoma cepedianum—Gizzard-shad; hickory shad.
2 colls. 17 spms. Habitat 9.

Family ANGUILLIDAE—The Eels

Anguilla chrysypa—Eel.
One reported taken in 1928 from the Embarrass River above Villa Grove.

Family CATOSTOMIDAE—The Suckers

KEY TO THE GENERA

- a Dorsal fin elongate, with 25 to 40 developed rays.
 - b Distance from eye to lower posterior angle of preopercle about $\frac{3}{4}$ of that to upper corner of gill-cleft. Subopercle broadest at its middle, sub-semicircular. (Buffaloes).....**Ictiobus**
 - bb Eye about equidistant between upper corner of gill-cleft and the lower posterior angle of preopercle. Subopercle broadest below its middle, subtriangular. (Carp-suckers).....**Carpiodes**

- aa Dorsal fin short, with 9 to 18 developed rays.
- c Lateral line more or less incomplete or wholly wanting.
Scales large and uniformly distributed, 30 to 50 in lateral line.
- d Lateral line entirely wanting at all ages. Mouth sub-inferior, somewhat oblique. Young with wide, black lateral band breaking up into about six dark blotches in adults. (Chub-sucker) **Erimyzon**
- dd Lateral line more or less developed in adults. Mouth inferior, horizontal. One dark squarish spot in center of each scale. (Spotted sucker) **Minytrema**
- cc Lateral line complete and continuous.
- e Scales small and crowded anteriorly. The number in the lateral line 55 to 110 (Except **C. nigricans** for which see below ee). (Suckers) **Catostomus**
- ee Scales large and nearly equal all over the body, 40 to 55 in the lateral line.
- f Air-bladder in two parts. Scales 48-55 in lateral line. (Hog sucker) **Catostomus (Hypentelium) nigricans**
- ff Air-bladder in three parts. Scales larger, 40 to 50 in lateral line. (Red-horses) **Moxostoma**

Key to the Species of Ictiobus

- a Mouth large, oblique. Upper lip about on level with lower margin of orbit. Angle of mandible with horizontal more than 40° **cyprinella**
- aa Mouth smaller, little oblique. Level of upper lip about midway between chin and lower margin of orbit. Angle of mandible with horizontal slight, less than 20°
- b Back scarcely elevated. Depth 3 to 3¼ in length. Body of adults subcircular at front of dorsal **urus**
- bb Back elevated. Depth 2½ to 2¾ in length. Body strikingly compressed in adults **bubalus**

Ictiobus cyprinella—Red-mouth buffalo; big-mouth buffalo.
1 coll. 3 spms. Habitat 9.

Ictiobus urus—Mongrel buffalo; round buffalo.
1 coll. 1 spm. Habitat 8.

Ictiobus bubalus—Small-mouth buffalo; high-back buffalo.
One taken in 1901 in Sangamon River. See Forbes and Richardson (1909).

Key to the Species of Carpiodes

- a Distance from anterior nostril to end of snout less than diameter of eye. Snout blunt, squarish at tip. Profile of head flattish or slightly concave. Eye large, 3¾ to 4½ in head **difformis**
- aa Distance from anterior nostril to end of snout greater than diameter of eye. Snout pointed at tip. Profile of head convex. Eye small, 4¾ to 5½ in head **velifer**

Carpiodes difformis—Blunt-nosed river carp.
4 colls. 30 spms. Habitat 9.

Carpiodes velifer—Quillback; silver carp.
9 colls. 13 spms. Habitats 8, 6, 9.

Erimyzon sucetta oblongus—Chub sucker; sweet sucker.
48 colls. 196 spms. Habitats 1, 5, 4, 6, 8, 9.

Minytrema melanops—Spotted sucker; striped sucker.
5 colls. 18 spms. Habitats 9, 8, 5.

Key to the Species of Catostomus

- a Head transversely convex above. The orbital rim not elevated. Scales in lateral line, 60 or more, crowded and smaller anteriorly *commersonii*
- aa Head broad, depressed, transversely concave between the orbits. Scales nearly equal all over the body, not crowded anteriorly, 48 to 55 in the lateral line..... *nigricans*

Catostomus commersonii—Black sucker; fine-scaled sucker.
65 colls. 644 spms. Habitats 8, 5, 6, 9, 4, 2, 7.

Catostomus nigricans—Hogsucker; stone-roller.
27 colls. 64 spms. Habitats 7, 8, 6, 5.

Key to the Species of Moxostoma

- a Folds of lower lip more or less broken up into papillae.
- b Head short, $4\frac{1}{2}$ to $5\frac{1}{2}$ in body. Caudal fin pink to bright red outward. Base of scales dark, giving a cross-hatched appearance. Developed dorsal rays 12 or 13..... *breviceps*
- bb Head longer, $3\frac{1}{2}$ to $4\frac{1}{2}$ in body. Mouth large. Developed dorsal rays 14 to 16. Back elevated. Color silvery..... *Anisurum*
- aa Lips strongly plicate. Head 4 to $4\frac{1}{2}$ in body. Caudal grayish olive to lemon. Outer margin of scales with dark stippling. Mouth large. Developed dorsal rays 12 to 14. Back scarcely elevated. Color bronze above lateral line..... *aureolum*

Moxostoma anisurum—White-nosed sucker.
One adult taken in September, 1929, from Sangamon River five miles above Mahomet.

Moxostoma aureolum—Common red-horse; white sucker.
22 colls. 114 spms. Habitats 8, 9, 7, 5, 6.

Moxostoma breviceps—Short-headed red-horse; red-tail.
6 colls. 11 spms. Habitats 8, 9, 6.

Family CYPRINIDAE—The Minnows and the Carp

KEY TO THE GENERA

- a Dorsal fin elongate. Dorsal and anal fins each with a strong serrated spine. Teeth molar or submolar. (Carp)..... **Cyprinus**
- aa Dorsal fin short. No spines in fins. Teeth not molar.
 - b Intestine more than twice length of body. Peritoneum usually black, brown, or dark gray. Generally mud-eaters.
 - c Intestine spirally wound around air-bladder..... **Campostoma**
 - cc Intestine not wound around air-bladder.
 - d Scales before dorsal 12 to 16 in number, not crowded..... **Hybognathus**
 - dd Scales before dorsal small and considerably crowded, 22 to 25 in number..... **Pimephales**
 - bb Intestine less than twice the length of body. Peritoneum usually pale. Generally carnivorous, or partly so.
 - e Maxillary without barbel.
 - f Mouth extremely small and upturned, the angle with vertical formed by its cleft less than 40°..... **Opsopoeodus**
 - ff Mouth horizontal or more or less oblique, the angle with vertical formed by its cleft usually more than 40°.
 - g Abdomen behind ventral fins with a sharp keel-like edge over which the scales do not pass. Body much compressed. Anal fin long, its rays 12 to 14..... **Abramis**
 - gg Abdomen behind ventrals never sharply keeled, but rounded and fully scaled. Form various, elongate or fusiform, or more or less compressed.
 - h First (rudimentary) ray of dorsal club-like, covered with thick skin, and separated from second ray by a distinct membrane..... **Cliola**
 - hh First (rudimentary) ray of dorsal slender and bony and closely attached to second.
 - i Lips normal, nowhere conspicuously thickened. Mouth subterminal, more or less oblique.
 - j Lower portion of head rounded, not swollen, and without externally visible mucus channels **Notropis**
 - jj Lower portion of head with an appearance of being swollen. The suborbitals, interopercles, and dentaries with greatly distended mucus cavities, appearing externally as transverse vitreous streaks..... **Ericymba**
 - ii Lower lip with two lateral fleshy lobes, separated at the middle by the more or less horny and knob-like chin. Scales rather small. 40 to 60 in lateral line..... **Phenacobius**
 - ce Maxillary with a barbel at or near its extremity (sometimes quite small and difficult to make out, especially in preserved specimens).
 - k Barbel on upper side of maxillary and distinctly in front of its posterior tip. Mouth exceptionally large, maxillary 2.4 to 2.8 in head. Scales 50 to 60..... **Semotilus**

- kk** Barbel terminal on the maxillary, situated in the axil formed at meeting of upper and lower lip-grooves. Maxillary more than 2.8 in head. Scales 35 to 45 in lateral line **Hybopsis**

Cyprinus carpio—Carp; European carp.
9 colls. 15 spms. Habitats 8, 9.

Campostoma anomalum—Dough-belly; stone roller.
64 colls. 1146 spms. Habitats 6, 7, 8, 2, 1, 4, 5.

Hybognathus nuchalis—Silvery minnow.
9 colls. 68 spms. Habitats 5, 8, 6, 7. Restricted to Kaskaskia River basin. Found among submerged vegetation, brush, and other cover.

Key to the Species of **Pimephales**

- a** Body short and stout, depth 3 to 4 in length. Lateral line more or less incomplete **promelas**
aa Body moderately elongate, depth 4 to 5 in length. Lateral line complete **notatus**

Pimephales promelas—Fathead minnow; black-head minnow.
19 colls. 103 spms. Habitats 8, 6, 4. Restricted to Sangamon River basin. Found in quieter water of permanently flowing streams.

Pimephales notatus—Blunt-nosed minnow.
110 colls. 6440 spms. Habitats 4, 5, 2, 6, 8, 1, 7, 9.

Opsopocodus emiliae—Snub-nosed minnow.
1 coll. 2 spms. Habitat 5.

Abramis crysoleucas—Golden shiner; bream.
41 colls. 401 spms. Habitats 5, 8, 6, 3, 2, 4, 7. Almost invariably found among vegetation or other cover.

Cliola vigilax—Bullhead minnow.
4 colls. 24 spms. Habitat 8. Restricted to the Sangamon River and the East Branch of the Salt Fork. Found in shallow, quiet water with mud bottom and no vegetation, cover or shade.

Key to the Species of **Notropis**

- a** Anal rays typically 7 or 8, occasionally 9 in two compressed forms (see **bb** below), in which however, scales before dorsal are not over 17, and no black spot is present at base of first dorsal rays.
b Eye moderate, $2\frac{1}{2}$ to $2\frac{3}{4}$ in head, always less than 4. Body not usually much compressed, the body gently and broadly rounded in front of dorsal fin. Scales not closely imbricated.
c Eye 3 or more in head. Small, usually less than $2\frac{1}{2}$ inches.

- d Scales before dorsal large, 12 to 15 in number.
 e A black stripe along sides through eye to end of snout. Chin white. Mouth small, nearly horizontal. _____ *cayuga*
- ee A dark vertebral streak, and a plumbeous lateral band more or less distinct posteriorly. Mouth more or less oblique. Lateral line distinctly decurved anteriorly. _____ *blennius*
- dd Scales before dorsal smaller, 17 to 19 in number. Mouth inferior. Lips rather thick. _____ *gilberti*
- cc Eye very large, $2\frac{1}{2}$ to $2\frac{3}{4}$ in head. Dark lateral stripe not developed anteriorly. Some dusky color on chin at tip. Length 3 inches. _____ *illecebrosus*
- bb Eye small, 4 to 5 in head in adults. Body more or less distinctly compressed, the back sharply rounded in front of dorsal fin. Scales closely imbricated. Adults with depth $3\frac{1}{2}$ to 4 in length. A more or less distinct black blotch on last membranes of dorsal. _____ *whipplii*
- aa Anal rays 9, 10, 11, or 12.
 f Dorsal in front of or over ventrals. Exposed portions of scales of flanks notably deeper than long. A broad dark vertebral streak. Anal rays 9 to 10, usually 10. _____ *cornutus*
- ff Dorsal fin behind ventrals. Scales roundish, the exposed portions not notably deeper than long.
 g Scales loosely imbricated, those before dorsal in 15 to 17 series. No black spot at base of dorsal.
 h A dark vertebral streak. Anal rays 9 or 10. _____ *pilsbryi*
- hh Vertebral streak very narrow and usually faint. Snout blunt. Maxillary equal to eye. _____ *atherinoides*
- gg Scales closely imbricated, about 30 series in front of dorsal. A black spot usually evident at front of base of dorsal. Anal rays 10 to 12, usually 11. _____ *umbratilis*

Notropis cayuga atrocaudalis—Cayuga minnow.
 1 coll. 1 spm. Habitat 8.

Notropis blennius—Straw-colored minnow.
 44 colls. 1573 spms. Habitats 8, 6, 7, 5, 1.

Notropis gilberti—Gilbert's minnow.
 5 colls. 53 spms. Habitats 6, 8, 5. Restricted to Sangamon River basin. Found in shallow, quiet water over sandy bottom.

Notropis illecebrosus—Big-eyed minnow.
 2 colls. 8 spms. Habitat 7. Restricted to Middle Fork River. Found below rapids among stalks of the water willow, *Dianthera americana*.

Notropis whipplii—Steel-colored minnow; silverfin.
 53 colls. 1994 spms. Habitats 8, 7, 6, 4, 2, 5. Found on or near riffles and briskly moving water. Strong swimmer.

Notropis cornutus—Shiner; horned shiner.

54 colls. 2618 spms. Habitats 5, 6, 7, 8, 4, 2, 9. Found abundantly in Sangamon, Middle Fork, and Kaskaskia River basins. A few specimens taken in Salt Fork Basin. Very closely associated with *Hybopsis kentuckiensis*.

Notropis pilsbryi—Pilsbry's minnow.

6 colls. 17 spms. Habitats 5, 6.

Notropis atherinoides var.—Shiner.

3 colls. 21 spms. Habitat 7. Restricted to Middle Fork River.

Notropis umbratilis atripes—Blackfin minnow.

69 colls. 1108 spms. Habitats 6, 5, 8, 7, in about equal frequency. Shows preference for vegetation or other cover.

Ericymba buccata—Silver-mouthed minnow.

79 colls. 3519 spms. Habitats 2, 6, 5, 8, 7, 4. Found most often and in largest numbers over sand bottom.

Phenacobius mirabilis—Sucker-mouthed minnow.

24 colls. 102 spms. Habitats 8, 6, 7, 5.

Semotilus atromaculatus—Horned dace; creek chub.

101 colls. 2873 spms. Habitats 4, 2, 1, 6, 5, 8, 7, 3.

Key to the Species of *Hybopsis*

- a Upper jaw decidedly inferior, lying below the projecting snout. Preorbital much narrower than eye. No nuptial tubercles. Upper jaw reaching eye.
- b Size small, 2 to 3 inches when adult. Dorsal fin inserted over origin of ventrals, usually a little nearer caudal base than tip of snout. Dark lateral stripe. Color silvery. Upper jaw 3.6 to 4.6 in head.....*amblops*
- bb Size large, 4 to 10 inches when adult. Dorsal fin inserted distinctly in advance of ventrals, decidedly nearer snout than caudal base. Color silvery without a dark lateral stripe. Upper jaw 3.2 to 3.7 in head.....*storerianus*
- aa Upper jaw almost terminal. Snout rather conical. Pre-orbital much wider than eye. Nuptial tubercles very strong. Large fishes with the aspect of *Semotilus*.....*kentuckiensis*

Hybopsis amblops—Big-eyed chub; silver chub.

8 colls. 40 spms. Habitats 8, 6. Restricted to Middle Fork, Salt Fork, and Embarrass rivers.

Hybopsis storerianus—Storer's chub.

One taken in 1899 in Middle Fork River. See Forbes and Richardson (1909).

Hybopsis kentuckiensis—Horny head; Kentucky chub.

46 colls. 1221 spms. Habitats 5, 6, 7, 8, 4, 9. Found closely associated with *Notropis cornutus* in Sangamon, Middle Fork, and Kaskaskia River basins

Family *SILURIDAE*—The Catfishes

KEY TO THE GENERA

- a Adipose fin with its posterior margin free.
 - b Premaxillary band of teeth without lateral backward extensions. Anal rays 17 to 35, including rudiments.
 - c Bony bridge from occiput to dorsal fin complete. Tail deeply forked *Ictalurus*
 - cc Bony bridge from occiput to dorsal fin broken. Caudal fin typically rounded, truncate or slightly emarginate *Ameiurus*
 - bb Premaxillary band of teeth with a backward extension on each side. Anal rays 12 to 15 including rudiments *Leptops*
- aa Adipose fin adnate to the back, continuous with the caudal and separated from it only by a notch.
 - d Premaxillary band of teeth with lateral backward extensions, as in *Leptops*. Skin thick tough, and villose, not translucent *Noturus*
 - dd Premaxillary band of teeth truncate at the ends, as in *Ameiurus*. Skin thinner than in d, smooth or very finely villose, sometimes translucent *Schilbeodes*

Ictalurus punctatus—Channel cat; fiddler.

8 colls. 10 spms. Habitats 8, 9.

Key to the Species of *Ameiurus*

- a Anal rays 24 to 27, including rudiments, usually 25 or 26. Caudal fin rounded posteriorly. Margin of anal fin a straight line *natalis*
- aa Anal rays 17 to 20, usually 18 or 19, including rudiments. Caudal fin always evidently emarginate. Margin of anal fin a curve *melas*

Ameiurus natalis—Yellow bullhead.

15 colls. 28 spms. Habitats 5, 6, 8.

Ameiurus melas—Black bullhead; horned pout.

13 colls. 1704 spms. Habitats 3, 5, 8, 9. Schools of young found in habitats 3, 5.

Leptops olivaris—Mud-cat; yellow cat; goujon.

One 24 pound spm. taken August 1928 in Sangamon River by Mr. Homer Bales.

Noturus flavus—Stonecat.

5 colls. 12 spms. Habitat 7. Found under rocks on riffles.

Key to the Species of *Schilbeodes*

- a Anterior and posterior edges of pectoral spine entire, or the anterior edge very slightly roughened near tip. Jaws equal. Adipose fin continuous with caudal, the notch being absent or faint, never acute. Color purplish olive to dark brownish, without noticeable specking. Three dark streaks on sides *gyrinus*
- aa Pectoral spine with distinct posterior serrae, which are re-curved and in length more than $1/3$ the diameter of spine. Notch between adipose and caudal fins always more or less acute.
 - b Pectoral spine short, 3 in head, the posterior serrae not $1/2$ diameter of spine. Notch between caudal and adipose fins usually shallow. Color light brown, sometimes faintly mottled. A large squarish spot of lighter color on back before dorsal and a smaller crescentic one behind it *exilis*
 - bb Pectoral spine longer, less than 2 in head, its posterior serrae strong and in length nearly equaling diameter of spine. Notch between adipose and caudal fins deep and acute. Color grayish with black specks and larger blotches. Four saddle-like blotches on back, the last but one extending upon adipose fin to its edge..... *miurus*

Schilbeodes gyrinus—Tadpole cat.

7 colls. 14 spms. Habitats 8, 6. Restricted to Salt Fork River basin.

Schilbeodes exilis—Slender stonecat.

3 colls. 3 spms. Habitats 8, 7.

Schilbeodes miurus—Brindled stonecat.

1 coll. 44 spms. Habitat 8. Restricted to Salt Fork River basin.

Family *ESOCIDAE*—The Pikes

Esox vermiculatus—Grass pike; little pickerel.

26 colls. 63 spms. Habitats 8, 5, 6. Found among submerged vegetation or other cover, and in the shade of overhanging bushes.

Family POECILIIDAE—The Killifishes*Fundulus notatus*—Top minnow.

44 colls. 151 spms. Habitats 8, 5, 6. Found most often near aquatic vegetation. Swims commonly with back touching the surface film.

Family ATHERINIDAE—The Silversides*Labidesthes sicculus*—Brook silverside.

3 colls. 27 spms. Habitat 8. Restricted to the Salt Fork River basin.

Family APHREDODERIDAE—The Pirate-perch*Aphredoderus sayanus*—Pirate-perch.

12 colls. 167 spms. Habitats 5, 8. Restricted to Sangamon, Embarrass, and Kaskaskia River basins. Found among living vegetation or other cover.

Family CENTRARCHIDAE—The Sunfishes

KEY TO THE GENERA

- a Dorsal fin little longer than anal, if any, its length 1 to 1.4 times length of anal base. Anal spines 5 to 8 in number.
 - b Dorsal spines 5 to 8 (occasionally 9 or even 10) (Crap-pies) **Pomoxis**
 - bb Dorsal spines 11 to 13. Anal spines 6, rays 10 or 11. (Rock bass) **Ambloplites**
- aa Dorsal more than twice length of anal. Anal spines 3.
 - c Body comparatively short and deep, depth in adults as a rule more than $\frac{2}{5}$ of length. Dorsal fin not deeply emarginate, the shortest spine behind middle of fin more than $\frac{2}{3}$ height of longest. Operculum entire behind, not emarginate, more or less prolonged in a bony process or flap with a rounded posterior margin.
 - d Tongue and pterygoids with teeth. Maxillary reaching past pupil (Warmouth bass) **Chaenobryttus**
 - dd Tongue and pterygoids toothless. Maxillary in most species short of middle of orbit (to middle in *L. cyanellus*). Pectorals never reaching beyond vertical from base of anal. Opercular flap without red, or if red is present, with the color forming a border and not a roundish spot. (Sunfishes, and the bluegill) **Lepomis**

- cc Body comparatively elongate, depth about $1/3$ length.
Dorsal fin deeply emarginate, the shortest spine behind
middle of fin from $1/3$ to $1/2$ height of longest. Oper-
culum ending in two flat points. (Black basses).....Micropterus

Key to the Species of *Pomoxis*

- a Dorsal spines typically 6, rarely 5 or 7. Color light, the dark
markings tending to form vertical bands.....annularis
aa Dorsal spines typically 7 or 8, rarely 6, 9, or 10. Color
dark, spotted, the dark markings not forming vertical bands.....sparoides

Pomoxis annularis—White crappie.
2 colls. 2 spms. Habitat 8.

Pomoxis sparoides—Black crappie.
3 colls. 7 spms. Habitats 9, 8.

Ambloplites rupestris—Rock bass; goggle-eye.
1 coll. 1 spm. Habitat 8.

Chaenobryttus gulosus—Warmouth bass.
2 or 3 spms. collected in recent years near the outlet of
Crystal Lake from which they had probably escaped.

Key to the Species of *Lepomis*

- a Black opercular spot borne by the stiff bony upper posterior
angle of the operculum, which is plainly distinguished from
a flexible (fleshy or membranous) border of different
(usually lighter) color.
b Mouth large and cheek not very deep, the maxillary $1/5$ to
 $1/4$ longer than the distance from the lower margin of
the orbit to the lower posterior corner of the preopercle.
In life with blue spots and vertical bars of dusky.
Margin of ear-flap coppery to purplish. Cheeks with
wavy blue linescyanellus
bb Mouth smaller and cheek deeper, maxillary about equal
to or less than distance from lower margin of orbit to
the lower posterior corner of preopercle. Many scales
of sides with squarish light-colored areas (bronze or
purplish in life), these forming more or less distinct
longitudinal rows. Rest of body dusky olive.....miniatus
aa Portion of opercular flap bearing black spot very thin and
flexible.
c Bony portion of operculum terminating in front of the
middle of the black opercular spot, which is confined
chiefly to the broad pale (pinkish in life) membranous
(not osseus) border. In life olive with orange spots.
Cheeks and opercles with wavy broken lines of rusty
orange. No black blotch at base of last dorsal rays.....humilis

- cc Bony portion of operculum continued backward as a thin and flexible osseo-membraneous flap, which is all or nearly all black, the longitudinal bone-striae being visible through its ensheathing epidermis.
- d Gill-rakers short and weak, their length not over $1/6$ eye. No black spot at base of last dorsal rays. Olive with blue and orange spots and wavy vertical streaks of emerald. Cheeks with wavy lines of emerald..... *megalotis*
- dd Gill-rakers rather long and slender, their length nearly $1/3$ of eye. A black blotch at base of last dorsal rays. Life color olive, with purplish luster..... *pallidus*

Lepomis cyanellus—Green sunfish.

38 colls. 121 spms. Habitats 3, 5, 6, 2, 8, 7, 4. Usually found among vegetation or other cover.

Lepomis Miniatus—Garman's sunfish.

1 spm. collected in 1928 near the outlet of Crystal Lake, from which it had probably escaped.

Lepomis megalotis—Long-eared sunfish.

39 colls. 154 spms. Habitats 8, 5, 6, 4, 9. About 20 adults observed building nests and spawning in the Little Vermilion River at the Champaign-Vermilion County line on August 2, 1928. The stream at this point is a dredge ditch with 3 to 10 inches of water and a muddy gravel bottom.

Lepomis humilis—Orange-spotted sunfish.

13 colls. 35 spms. Habitats 8, 2, 5, 6. Restricted to Sangamon, Salt Fork, and Middle Fork River basins.

Lepomis pallidus—Bluegill.

1 spm. taken in 1928 near the outlet of Crystal Lake, from which it had probably escaped.

Key to the Species of *Micropterus*

- a Mouth moderate, the maxillary never extending beyond eye, usually a little short of back of orbit. Scales on cheeks in about 17 rows. Young more or less barred or spotted, never with a black lateral band..... *dolomieu*
- aa Mouth very large, the maxillary in the adult extending past back of orbit. Scales on cheek large, in about 10 rows. Young with a blackish lateral band..... *salmoides*

Micropterus dolomieu—Small-mouthed black bass.

16 colls. 44 spms. Habitats 8, 7, 6, 9. Usually found near submerged brush or logs. Good swimmer. Commonly jumps clear of water when disturbed.

Micropterus salmoides—Large-mouthed black bass.

3 colls. 4 spms. Habitats 8, 6. It has been noticed that where this species is found in creeks there is usually a good growth of the water willow, *Dianthera americana*. Not so active as *M. dolomieu*.

Family PERCIDAE—The Darters

KEY TO THE GENERA

- a Pre-maxillaries not protractile, free only at the sides, connected in front with the skin of the forehead, from which they are not separated by a cross groove.
- b Cranium not compressed or much elevated back of eyes, its elevation not more than $\frac{1}{3}$ of its breadth. Body as a rule more or less slender and little compressed, subcylindrical or fusiform. Depth in length as a rule 6 or more. Spring males ordinarily without red or other gaudy coloration.
- c Cranium broad between the eyes, the interorbital space 4 to 4.7 in head. Snout pig-like. Darters of large size, reaching a length of 6 inches. (Log perch).....Percina
- cc Interorbital space narrower, 5.5 to 9 in head. Small fishes, ordinarily not over 4 inches in length. Body moderately slender, the depth as a rule about 6 in length (sometimes 7).....Hadropterus
- bb Cranium more or less compressed and elevated back of eyes, Ω -shaped, its elevation as a rule noticeably more than $\frac{1}{3}$ (to less than $\frac{1}{2}$) its breadth (except in **E. flabellare** which has a low spinous dorsal and spring males without gaudy coloration). Fishes with usually more or less compressed and comparatively shortened bodies, the depth in length as a rule less than 6. Spring males usually with brilliant red, blue, or green coloration.
- d Lateral line not noticeably flexed upward anteriorly.....Etheostoma
- dd Lateral line conspicuously flexed upward anteriorly, its direction parallel with line of back (least distance between lateral line and middle of back in **B. fusiformis** about $\frac{1}{4}$ depth of body at same point).....Boleichthys
- aa Premaxillaries protractile, i. e., a groove separating them from the skin of the forehead.
- e Groove separating premaxillaries from forehead inferior, not visible except from below. Maxillary adnate to the preorbital for most of its length, nearly immovable. Anal spines 2.....Diplesion

- ee Groove separating premaxillaries from forehead superior, easily visible from in front and above. Maxillary separated by groove from preorbital for its entire length. Anal spine single.
- f Anal fin much smaller than soft dorsal. Body moderately slender, depth not over 7 in length. Not hyaline in life **Boleosoma**
- ff Anal fin almost as large as soft dorsal. Body extremely slender, depth in length 8 to 10. Body hyaline in life..... **Ammocrypta**

Percina caprodes—Log perch.
2 colls. 4 spms. Habitat 7.

Key to the Species of Hadropterus

- a Gill membranes not broadly united at the isthmus, distance from tip of snout to angle formed by their union scarcely exceeding that to back of orbit. Color pattern longitudinal, the sides marked with a median row of blotches or a moniliform band, above which are longitudinally disposed marblings. Cheeks scaled..... **aspro**
- aa Gill membranes united at isthmus in a broad curve, least distance from muzzle to free margin of gill membranes 1.2 to 1.5 times that from muzzle to back of orbit. Head very slender and snout long and pointed. Lateral blotches small and as a rule faint. A very small central caudal spot **phoxocephalus**

Hadropterus aspro—Black-sided darter.
24 colls. 45 spms. Habitats 8, 5, 6, 7. Often found among aquatic vegetation or other cover.

Hadropterus phoxocephalus—Sharp-nosed darter.
8 colls. 12 spms. Habitats 8, 7, 6.

Diplesion blennioides—Green-sided darter.
10 colls. 149 spms. Habitats 7, 8, 6. Restricted to Middle Fork, Salt Fork, and Embarrass River basins. Found on swiftest riffles.

Key to the Species of Boleosoma

- a Lateral line complete or nearly so. Pyloric caeca 6. Cheeks and breast typically naked, sometimes more or less scaly..... **nigrum**
- aa Lateral line absent on posterior half of body. Pyloric caeca 3. Cheeks and opercles, and usually breast, closely scaled..... **camurum**

Boleosoma nigrum—Johnny darter.
82 colls. 993 spms. Habitats 8, 5, 6, 2, 4, 7.

Bolcosoma camurum—Snub-nosed darter.

1 coll. 1 spm. Habitat 5.

Ammocrypta pellucida—Sand darter.

2 colls. 19 spms. Habitat 8. Restricted to Middle Fork River. Found buried in sand above riffles.

Key to the Species of **Etheostoma**

- a** Lateral line usually complete, occasionally 2 to 6 pores lacking. Gill membranes joining broadly across the isthmus.....**zonale**
- aa** Lateral line always more or less incomplete, the number of pores lacking usually 10 to 30, rarely as low as 5.
 - b** Spinous dorsal fin not exceptionally low, its height as a rule 75 to 90 per cent of height of soft dorsal. No enlarged dark humeral scale.
 - c** Cheeks and opercles scaled. Brown bars on sides.....**jessiae**
 - cc** Cheeks naked. Opercles scaled. Spring males with alternating red and blue bars.....**coeruleum**
 - bb** Spinous dorsal fin as a rule less than 60 per cent height of soft dorsal. An enlarged dark humeral scale more or less conspicuous. Gill membranes broadly connected. Dorsal spines each ending in a fleshy knob in the male.....**flabellare**

Etheostoma zonale—Banded darter.

8 colls. 85 spms. Habitats 7, 8. Restricted to the Sangamon River.

Etheostoma jessiae—

One spm. taken in 1901 in Sangamon River. See Forbes and Richardson (1909).

Etheostoma coeruleum—Rainbow darter.

32 colls. 497 spms. Habitats 6, 7, 8, 5, 4. Not found in the Kaskaskia Basin.

Etheostoma flabellare—Fan-tailed darter.

14 colls. 34 spms. Habitats 7, 8, 6. Restricted to Sangamon, Embarrass, Middle Fork, and Salt Fork River basins. Found under and around rocks on riffles.

Boleichthys fusiformis—

1 coll. 1 spm. Habitat 6.

Family *SCIAENIDAE*—The Drums

Aplodinotus grunniens—Sheepshead; white perch; drum.

3 colls. 10 spms. Habitats 9, 8.

TYPE HABITATS

Habitat numbers given in the preceding species list refer to the following classification of type habitats as found in the streams of Champaign County. In the selection of these type habitats we have chosen those stream situations which occur repeatedly and have made them correspond, in as far as possible, with what appear to be natural subdivisions in the distribution of the fishes. It is, of course, to be understood that a stream is a continuum and does not break abruptly from one situation into another. There are marked differences in the details of the environment in these type habitats and corresponding differences in the detailed distribution of the fishes.

*Type Habitat 1**Vernal Rivulets*

Commonly draining $\frac{1}{2}$ to 2 square miles. Flowing for a few weeks in spring and for shorter periods following heavy rains. Completely dry throughout most of the year. One to six inches deep. Six inches to four feet wide. They are often so small that they can be dammed by one's hand. The substrate is of exposed subsoil with an accumulation of loam in the depressions. Occasional short stretches of sand bottom may occur depending on the kind of soil being eroded. There are no characteristic bottom muds nor gravelly or rocky riffles. There is usually considerable dead vegetation in the form of drifts of leaves, dead weeds, sticks, cornstalks, grass, etc. No living vegetation except for occasional pieces of sod. The aquatic animal food present for fishes is restricted almost entirely to water isopods. A considerable number of terrestrial animals are washed in and also serve as food. The typical species of this habitat are as follows:

Erimyzon sucetta oblongus, young
Pimephales notatus, young
Semotilus atromaculatus, young
Campestris anomalum, young

The above fishes are known to feed extensively on mud and organic debris. The young of a few other species may occur in small numbers.

*Type Habitat 2**Kettle Holes at Mouths of Tile Drains*

Commonly draining from 1 to 7 square miles. There is a flow throughout the year but it is often reduced to a trickle. Usually 10 to 25 feet wide and $1\frac{1}{2}$ to 4 feet deep. Water temperature not exceeding 65°F. in summer and seldom freezing in winter. Very clear. No aquatic vegetation except filamentous algae. Bottom usually of clay, rock, gravel, and sand. No characteristic dark-colored

5. On the afternoon of July 28, 1929, two of these kettle holes were visited and temperatures taken. On that afternoon the air temperature in the shade varied around 95°F. The temperature of one was 63.3°F. and the other 62.6°F. The water temperature as it came from the two tiles was 62.8°F. and 61.3°F., respectively.

bottom muds. No cover except a little overhanging grass and some submerged trash, dead leaves, and weeds. Very little available aquatic animal food apparent. Grasshoppers and other terrestrial insects fall into the water and probably fill an important place in the dietary of the fishes. No shade. The typical fishes in these situations are as follows:

Ericymba buccata, adults
Semotilus atromaculatus, adults and young
Pimephales notatus, adults
Catostomus commersonii, young
Camptostoma anomalum, adults and young

When the tile outlet is sufficiently low some of these fishes, notably *Ericymba* and *Semotilus*, will ascend the tile for considerable distances where they may feed on subterranean amphipods and isopods.

Type Habitat 3

Oxbow Ponds along Small Streams

Commonly draining $\frac{1}{2}$ to 1 square mile. Flowing during wet weather. Flooded by adjacent stream during freshets. Usually wide, shallow ponds with a bottom of deep, soft, black, mucky mud. Much dead and decaying vegetation. Usually with emergent coarse aquatic vegetation of *Sagittaria*, smartweeds, bullrushes, docks, etc. In summer with heavy growths of blanket algae and duck weeds. Seldom shaded; water extremely warm in summer weather. Freezes almost to bottom in winter. Numbers of frog tadpoles of several species can often be found. Small crayfishes numerous. An abundance of a large variety of aquatic animal food. The typical fishes are as follows:

Ameiurus melas, adults and young
Lepomis cyanellus, adults and young
Esox vermiculatus, adults and young
Abramis crysoleucas, adults and young

Occasional young specimens of other species are also found. The conditions of these small oxbow ponds are sometimes approximated in the upper ends of dredge ditches and there the above fishes are also found.

Type Habitat 4

Permanent Headwater Streams

Commonly draining 2 to 10 square miles. Reduced during drouths to mere trickles running from one shallow depression to another. One inch to one foot deep and six inches to six feet wide. Substrate usually of exposed subsoil but occasional gravelly riffles and beginnings of characteristic bottom muds are seen. Shaded by a luxuriant growth of cattails, grasses, weeds, willows, and other shrubs and small trees. Water cool. No submerged coarse aquatic vegetation. May have some duck weed and filamentous algae in summer. Available aquatic animal food for fishes not abundant. Numbers of dragon fly and damsel fly nymphs and

water striders and other bugs. Much food probably falls from the overhanging vegetation. The typical fishes in this situation are:

Semotilus atromaculatus, adults and young
Pimephales notatus, adults and young

Sometimes the fish population consists entirely of *Semotilus*. At other times a few specimens of other species may also be found.

Type Habitat 5

Stretches of Shallow, Sluggish Water

Found in both dredged and undredged streams with a drainage area of 5 to 40 square miles. Reduced to long quiet pools in dry weather. Three to twenty feet wide and $\frac{1}{2}$ to $2\frac{1}{2}$ feet deep. In summer the water is relatively warm and is turbid. In winter covered with heavy ice. The bottom is characteristically of dark mud with an admixture of small amounts of sand, gravel, rock, and sticks. The banks are usually steep and drop off quickly to an almost uniform depth. There is characteristically a growth of a variety of submerged and emergent coarse aquatic vegetation, and the channel often is literally choked with beds of water smartweed. Small amounts of shade are furnished by overhanging grass and weeds and a few willows. A variety of aquatic animal foods is present in fair abundance, with *Hexagenia* nymphs near first place. Crayfishes are common and often are extremely abundant. The typical fishes in this habitat are:

Catostomus commersonii, adults and few young
Notropis cornutus, adults and young
Hybopsis kentuckiensis, adults and young
Semotilus atromaculatus, adults and young
Abramis crysoleucas, adults and young
Erimyzon sucetta oblongus, adults and young
Esox vermiculatus, adults and young
Fundulus notatus, adults and young
Pimephales notatus, adults and young
Aphredoderus sayanus, adults and young
Lepomis megalotis, adults and young
Lepomis cyanellus, adults and young
Bolcosoma nigrum, adults and young

Small numbers of other fishes are regularly taken. This is one of the more important fish habitats inasmuch as it occurs commonly in Champaign County and supports a large population of a variety of fishes.

Type Habitat 6

Gravelly and Sandy Riffles and Stretches

Drainage area 8 to 40 square miles. One to 12 feet wide and 1 to 8 inches deep. May be a few feet long or several hundred yards long. Either in dredged ditches or in natural streams that loop and meander. Small flow in dry weather.

Bottom of gravel or sand, more commonly of both. Often with pebbles ranging up to two inches or more in diameter. Mud along banks and in shallow depressions. Exposed roots of willow, brush, and overhanging sod and grass and shore vegetation. Sometimes there are small amounts of coarse aquatic vegetation. Moderate amounts of aquatic animal food. The typical fishes are:

Catostomus nigricans, young and few adults
Camptostoma anomalum, adults and young
Semotilus atromaculatus, adults and young
Notropis whipplii, adults and young
Catostomus commersonii, young
Notropis cornutus, adults and young
Hybopsis kentuckiensis, adults and young
Pimephales notatus, adults and young
Ericymba buccata, adults and young
Notropis umbratilis atripes, adults and young
Boleosoma nigrum, adults and young
Etheostoma coeruleum, adults and young
Etheostoma flabellare, adults and young
Moxostoma aureolum, young
Carpiodes velifer, young

Smaller numbers of other fishes are regularly taken.

Type Habitat 7

Rocky Rapids and Riffles

Draining 40 to 400 square miles. Depth 2 to 15 inches. Width 5 to 40 feet, very swift except during very low stages of water. Commonly 10 to 100 yards long. Bottom of rocks from the size of eggs up to boulders and loose trap rock interspersed with solidly packed gravel and sand. Occasional logs and brush in water along edges. Rocks overgrown with spreading growths of algae, diatoms, bryozoa, etc., and often serving as anchors for long streamers of *Cladophora*. An abundance of animal food, consisting principally of small mollusks and immature stages of may flies and caddis flies. This situation occurs in both dredged and natural streams. There are usually trees and shrubs on the banks, which partially shade the water. The typical species of this habitat are:

Catostomus nigricans, adults
Phenacobius mirabilis, adults and young
Ictalurus punctatus, young
Etheostoma flabellare, adults and young
Etheostoma zonale, adults and young
Hybopsis kentuckiensis, adults and young
Notropis cornutus, adults and young
Notropis whipplii, adults and young
Hybopsis amblops, adults and young
Percina caprodes, adults
Diplesion bleinioides, adults and young
Noturus flavus, adults and young

Small numbers of other fishes taken under certain conditions. The fishes of this situation are mostly adapted to hiding behind and under rocks or other objects that break the full force of the current. These species are seldom seen swimming except for sudden spurts of speed from one stopping place to another. They hold their position rather by avoiding the full force of the current and clinging than by excellence of swimming.

Type Habitat 8

Moderately Deep, Smoothly Flowing Stretches

Draining 40 to 400 square miles. Depth 1 to 4 feet. Width 20 to 50 feet. Current sluggish during periods of low water. Bottom of sand and gravel with mud along the banks. No coarse aquatic vegetation. Usually with no overhanging grass or weeds. Commonly shaded by trees on the banks. Roots of trees often exposed and offer hiding places for sunfishes. Numerous drifts of brush and logs and stumps commonly accumulated in places where a large tree has fallen in. The banks usually drop off steeply to a uniform depth. Moderate amounts of a variety of animal foods. Mussels of several species numerous. The typical fishes of this situation are:

Moxostoma aureolum, adults
Moxostoma breviceps, adults
Carpiodes velifer, adults
Catostomus commersonii, adults
Catostomus nigricans, adults
Micropterus dolomieu, adults and young
Pomoxis annularis, adults and young
Pimephales notatus, adults
Notropis blennioides, adults
Notropis whifflii, adults
Notropis cornutus, adults
Hybopsis kentuckiensis, adults
Ictalurus punctatus, adults and young
Lepomis cyanellus, adults and young
Lepomis megalotis, adults and young
Lepomis humilis, adults and young

Other fishes are also taken in smaller numbers.

Type Habitat 9

Long, Deep Pools

Draining 100 to 400 square miles. Width 40 to 75 feet. Depth 3 to 8 feet. There is less fluctuation of the physical environment of this habitat than any other small stream situation. Mud bottom with more or less gravel and water-logged sticks. Mud banks. Usually with partly submerged logs and brush along banks. Partly shaded by trees. Sometimes turbid. No aquatic vegetation except for water bloom and duck weed in late summer. Usually with aquatic animal food

in the form of small mollusks, Tubificid worms, and chironomid larvae. The typical fishes are:

Aplodinotus grunniens, adults and young
Dorosoma cepedianum, adults and young
Carpiodes difformis, adults
Moxostoma aurcolum, adults
Moxostoma breviceps, adults
Micropterus salmoides, adults and young
Ictiobus cyprinella, adults and young
Cyprinus carpio, adults and young
Catostomus commersonii, adults
Pomoxis sparoides, adults and young
Ictalurus punctatus, adults
Ameiurus melas, adults

Other large fishes are taken in smaller numbers. Scanty numbers of smaller kinds of fishes are taken regularly. Snapping turtles are found here most often. Painted turtles numerous. This situation is the winter quarters of most of the larger fishes.

ABUNDANCE AND NUMBER OF KINDS

In the present quantitative collections a total of 28,905 fishes were taken from a total water area of 9,535 square yards or 1.97 acres—about 15,000 per acre, or 3 per square yard. The total weight of these fishes was estimated at 300 pounds, or about 150 pounds per acre for the county streams as a whole. This average weight of fish flesh per acre has no obvious relation to the annual yield of food fishes or to the annual increment.

On the basis of some fragmentary data on the rate of growth of Champaign County fishes and on a general knowledge of the size and relative numbers of the different age groups of the principal species, one may venture a guess that the annual increment, or turnover, of fish flesh is something less than one-half of the total 150 pounds per acre.

In this area food and game fishes may be taken only by hook-and-line, and minnows may be taken for bait with small minnow seines. In general, the fishes in this county are too small to be attractive to many anglers, and the weight of the fishes taken from the water by man is surely a very small percentage of the annual increment. In these streams we probably have a close approximation to an equilibrium, or a balance wherein the annual increase in fish flesh equals the annual decrease, and that without undue influence or control by man. Most fishes in these streams die of "natural" causes—they may be eaten at any period of their life by any one of a variety of predators such as carnivorous insects, crayfishes, necturi, turtles, water and shore birds, or the mink. They may be injured or stunted or destroyed by any one of a long and imposing list of specific fish diseases and parasites. Under certain conditions their food may be exhausted or seriously depleted. Their ambient medium may dry up or get too hot or freeze solid or be deficient or unsuitable in a number of other ways. Compared with these vicissitudes an occasional worm on a hook is a minor hazard.

Some recent work of Dr. H. J. Van Cleave and Mr. H. C. Markus on the life history of the blunt-nosed minnow, *Pimephales notatus*, in this area suggests that females and males of this species do not exceed 2 and 3 years in age, respectively. The implication is that they die following their first spawning period. (*Amer. Nat.* 63: 530-539, 1929.)

Of those species which occur both in these small streams and in the large rivers of Illinois the average size is much less in the small streams. Such size differences among the suckers and red-horses are obviously due to migration, since these fishes ascend the small streams and spawn and then descend. Size differences may also be due to slower growth or greater relative elimination in the small streams. In any case it seems probable that the annual "turn-over" in fish flesh is greater in these small streams than in the larger rivers.

Eight of the thirteen families of fishes in Champaign County are represented by single species. The remaining five families are represented by species as follows: Catfishes 8, Suckers 12, Sunfishes 11, Darters 12, Minnows 23. In point of weight the sucker family (*Catostomidae*) takes first place, furnishing somewhat more than half of the total weight of fishes taken. About three-fourths of this total weight of the sucker family was contributed by the common, or black, sucker, *Catostomus commersonii*, which averaged 3 ounces in weight. In point of numbers of individuals the minnow family (*Cyprinidae*) excels, contributing 23,347 of the total of 28,905 specimens taken. Of the 23 species of minnows taken, the following 9 species furnished 22,492 specimens.

Camptostoma anomalum
Pimephales notatus
Semotilus atromaculatus
Notropis blennioides
Notropis whiffplii

Notropis cornutus
Notropis umbratilis atripes
Ericymba buccata
Hybopsis kentuckiensis

Most of these are headwater species, generalized, both physiologically and morphologically, and will be discussed more fully later.

To illustrate the wide range of abundance, one species is represented by 6,440 specimens in one season's collecting, while 12 others are represented by single specimens each. Such differences in abundance of the various species as we find in this study are not satisfactorily explained by one or a few factors, and it seems that an adequate explanation will involve not only a complete and intimate knowledge of all the variable factors of the physical environment but—what is more difficult—an equally complete and intimate knowledge of the fishes themselves and of their various responses to the environment. Any factor is important to the extent in which it limits the life and abundance of any kind of fish. And, as a corollary, all factors are important at least as they exceed certain threshold limits.

Considerable information and observation on individual species, together with the quantitative data, make possible a rather critical analysis of some of the factors affecting fish distribution and abundance. Environmental factors known to be of importance in these small streams are: volume of water; depth of stream; rate of flow; permanency of stream (*i. e.*, whether or not it is reduced to pools in dry weather); submerged vegetation, shade, and other cover; kind of bottom; temperature

variation; fertility of soil of drainage basin; pollution; and catastrophe (unknown factors which destroy or drive out whole species from within one or more stream systems). Biological factors known to be of importance are: migration, activity in winter (metabolism), morphological adaptation, physiological adaptation, diet, size, habit (*c. g.*, sedentary or active), disease, introduction of new kinds, association of species independent of the environment, association of species showing preference for same environment, predator-prey relationship, and modern and primitive groups.

RELATION OF DISTRIBUTION AND ABUNDANCE TO STREAM SIZE

All of the kinds of fishes with which we are dealing exhibit frequencies which vary with stream size in a very consistent and definite manner for each species. Small streams flowing into large streams have no more large-stream fishes than do small streams that increase slowly over many miles of length. It can be shown that some species which reach greatest numbers at certain points in a stream also reach greatest numbers in other streams at points with the same drainage area, without reference to distance from headwaters or from the mouth. In certain species the entire population is confined to a certain stream size with very narrow limits, while other kinds may occur in all sizes of streams but show abundances which fluctuate about a certain stream size as a mode. The young of some of the species of suckers have their greatest frequency in smaller streams than do the adults. In most fishes, other than the suckers, both the young and the adults occur most abundantly in the same size of stream.

Forbes and Richardson (1909) expressed the relation of stream size to the distribution of the different species by the relative frequency of occurrence in larger rivers, smaller rivers, and creeks. In their system of classification all of the streams of Champaign County would probably come under the general heading of creeks. Hankinson⁶ used a similar method. Shelford⁷, in considering this same subject of distribution of fishes in streams, has brought out most of the principal facts of the problem. One of the more important points he states is "that the different fish communities are closer together in the smaller streams."

Several methods for expressing in a statistical manner this greater proximity of fish communities in the smaller streams were tried. It was found that the most satisfactory method was to consider the streams in classes in which each class is twice the preceding class, that is, in a geometrical progression. Since the streams studied here varied in drainage area from 0.7 up to 378 square miles, they fell very conveniently into ten classes beginning with 0.5-1.0 and ending with 256-512 square miles. The validity of this method of classification is indicated in Fig. 6 where the number of species per collection and the number of fishes per square yard have been plotted from data given in the tables mentioned on page 17. As is commonly the case, the ends of the curves are based on smaller numbers of determinations and, hence, are more vari-

6. Hankinson, T. L., "Distribution of Fish in the Streams About Charleston, Illinois." Trans. Ill. Acad. Sci., 6:102-113, 1913.

7. Shelford, Victor E., "Ecological Succession. I. Stream Fishes and the Method of Physiographic Analysis." Biol. Bul. 21:9-34, 1911.

able. In order to smooth the curves the three classes at each extreme have been averaged and plotted, so that we now have points on the curves representing approximately equal numbers of observations. The fact that these two biological functions of stream size give curves that approximate straight lines is good empirical reason for assuming that this is the correct method for comparing the life of streams of widely varying sizes. There is the further convenience that the distribution of the collections in the different size classes is fairly uniform; whereas, if ten arithmetical classes of 0-40, 40-80, 80-120, *etc.*, had been used, more than two-thirds of the total number of observations would have fallen in the 0-40 class. It seems that this method of tabulation may be advantageously extended in biological studies to compare the range of adaptability of different species to different stream sizes, varying from the smallest we have mentioned here up to, let us say, the size of the Mississippi at New Orleans. If, for example, we find that the spoonbill cat

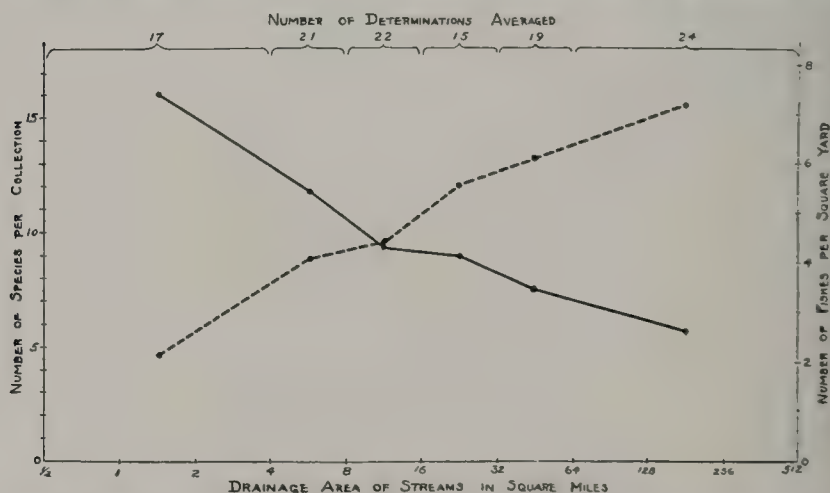


Fig. 6. Graph showing relation of variety and abundance of fishes to stream size. The solid line indicates number of fishes per square yard, and the dotted line number of species per collection.

inhabits streams of sizes varying over 8 size classes in this scale (*e. g.*, from the Mississippi at New Orleans up to Sterling on the Rock River in Illinois) and that the rainbow darter likewise ranges over 8 size classes (*e. g.*, in the headwaters of the Sangamon River in Champaign County) we may say that they have the same *range of adaptability* to stream size, even though the total range of the spoonbill cat is over two thousand miles of river and that of the rainbow darter is only twenty miles of creek.

In Tables I to VIII are given the frequencies of the different fishes taken in the 1928 collections in average numbers per 100 square yards for streams of each size. Nineteen of these species are obviously restricted in their distribution to certain stream systems. The average numbers per 100 square yards for these species are based only on those stream systems in which they occurred and not on the county as a whole.

Thus, in the case of *Erimyzon succetta oblongus*, the chub sucker, which occurs generally in all the stream systems, there are on an average 6.0 individuals per 100 square yards in streams with 8-16 square miles of drainage area; while in the case of *Hybognathus nuchalis*, the silvery minnow, which is restricted to the Kaskaskia River basin, there are on an average 5.6 individuals per 100 square yards in streams with 8-16 square miles of drainage area and none elsewhere.

TABLE I. SUCKERS—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Erimyzon succetta oblongus</i>	29.4		2.3	5.7	6.0	1.6	0.2	0.9	0.2		
<i>Catostomus commersonii</i>		6.6	1.2	35.7	9.0	2.2	7.2	9.5	2.1	1.1	
<i>Catostomus nigricans</i>				0.1	0.8	0.7	1.5	0.4	1.2	0.6	
<i>Minytrema melanops</i>					0.1			0.2	0.9		
<i>Moxostoma aureolum</i>				0.6		0.1	0.4	1.7	4.5	1.2	
<i>Moxostoma breviceps</i>						0.1	0.2	0.1	0.2	0.1	
<i>Carpiodes velifer</i>						0.5	0.1	0.2	0.4	0.3	
<i>Carpiodes difformis</i>								0.9	1.1	0.2	
<i>Ictiobus urus</i>									0.1		
<i>Ictiobus cyprinella</i>											0.1

TABLE II. MUD-EATING MINNOWS—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Campostoma anomalum</i>	14.0	92.0	6.7	96.5	29.8	11.3	13.3		5.3	1.7	
<i>Pimephales notatus</i>	36.0	78.0	62.3	164.6	87.9	124.5	63.1	49.6	87.1	35.1	
<i>Pimephales promelas</i> *				14.5	22.7	2.7	5.2	3.0	2.6	0.5	
<i>Hybognathus nuchalis</i> †					5.6	6.3	5.0	10.0			

* Restricted to Sangamon River Basin.

† Restricted to Kaskaskia River Basin.

TABLE III. MINNOWS OF THE GENUS *NOTROPIS*—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>N. cornutus</i> *		10.0	25.0	88.8	64.3	122.6	141.0	31.7	35.8	10.8	
<i>N. whiplii</i>		4.0	1.1	8.1	2.3	20.1	7.9	12.1	50.5	54.3	
<i>N. blennioides</i>		2.0		1.5	2.5	14.0	57.7	18.7	28.9	21.7	
<i>N. umbratilis atripes</i>				24.5	6.8	15.3	17.6	16.4	18.9	5.8	
<i>N. pilsbryi</i>					0.7	1.1					
<i>N. gilberti</i> †						1.3	5.0			2.8	
<i>N. atherinoides</i> -var.‡									9.0		
<i>N. illecebrosus</i> §									3.8		
<i>N. cayuga</i>									0.1		

* Restricted to Sangamon, Middle Fork, and Kaskaskia River Basins.

† Restricted to Sangamon River Basin.

‡ Restricted to Middle Fork River Basin.

§ Restricted to Middle Fork River Basin.

TABLE IV. OTHER MINNOWS AND THE CARP—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Semotilus atromaculatus</i>	562.4	177.0	54.0	69.2	142.7	30.3	18.4	4.3	3.3	9.3	
<i>Ericymba buccata</i>	2.0	510.0			58.4	82.4	100.0	71.4	37.3	33.2	12.6
<i>Abramis crysoleucas</i>	7.0	1.0	7.6	11.1	0.7	5.6	4.7	5.3	5.0		
<i>Hybopsis kentuckiensis</i> *			4.5	2.0	46.9	74.1	33.6	11.3	17.6	9.2	
<i>Phenacobius mirabilis</i>				0.5	0.1	1.3	2.4	1.6	2.2	1.7	
<i>Hybopsis amblops</i> †					0.1	0.5	0.2	4.4	2.4		
<i>Opsopoeodus emiliae</i>					0.1						
<i>Cyprinus carpio</i>								0.1	0.2	0.2	0.4
<i>Cliola vigilax</i> ‡									4.7	0.4	0.7

* Restricted to Sangamon, Middle Fork, and Kaskaskia River Basins.

† Restricted to Middle Fork, Salt Fork, and Embarrass River Basins.

‡ Restricted to Sangamon and Salt Fork River Basins.

TABLE V. CATFISHES—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Ameiurus melas</i>	750.0				22.3	0.1	0.6	0.1	0.2	0.2	0.1
<i>Ameiurus natalis</i>					0.4	0.7	0.9	0.1		0.3	
<i>Schilbeodes gyrimus</i> *					0.2	0.6		1.2		0.2	0.2
<i>Schilbeodes miurus</i> †								9.8			
<i>Ictalurus punctatus</i>								0.2		0.6	0.2
<i>Noturus flavus</i>										1.0	0.1
<i>Schilbeodes exilis</i>										0.1	0.2
<i>Leptops olivaris</i>											+

* Restricted to Salt Fork River Basin.

† Restricted to Salt Fork River Basin.

TABLE VI. SUNFISHES AND BASSES—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Lepomis megalotis</i>	12.0				2.3	1.1	2.2	1.0	2.8	2.7	0.4
<i>Lepomis cyanellus</i>	5.0	5.0	0.3		3.5	2.7	1.6	0.7	0.2	0.5	0.8
<i>Lepomis humilis</i> *			1.2		0.7	0.2		0.7	2.2	1.3	0.1
<i>Micropterus salmoides</i>					0.4					0.2	
<i>Micropterus dolomieu</i>							0.2	1.0		0.8	0.4
<i>Ambloplites rupestris</i>								0.1		0.1	
<i>Pomoxis annularis</i>								0.1		0.1	
<i>Pomoxis sparoides</i>										0.2	0.2
<i>Chaenobryttus gulosus</i> †								+			
<i>Lepomis miniatus</i> †								+			
<i>Lepomis pallidus</i> †								+			

* Restricted to Sangamon, Middle Fork, and Salt Fork River Basins.

† Single specimens of these three species were taken in the Salt Fork near the outlet of Crystal Lake from which they apparently have escaped.

TABLE VII. DARTERS—AVERAGE NUMBER PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Boleosoma nigrum</i>		1.0	5.9	8.9	21.3	15.2	16.3	16.3	8.2	3.3	
<i>Etheostoma coeruleum</i> *		0.5	3.7	11.4	10.8	5.6			2.8	1.1	
<i>Hadropterus aspro</i>			0.3	0.3	0.4	0.3	0.4		1.2	1.1	
<i>Etheostoma flabellare</i> †				0.2	0.5	0.4	0.8		0.8	0.8	
<i>Boleosoma camurum</i>					0.1						
<i>Diplesion blennioides</i> ‡					+	0.1	0.1		11.5	0.1	
<i>Boleichthys fusiformis</i>						0.1					
<i>Hadropterus phoxocephalus</i>						0.1			0.8	0.6	
<i>Etheostoma zonale</i> §								4.6	1.8	7.7	
<i>Percina caprodes</i>								0.1	0.2		
<i>Ammocrypta pellucida</i> ¶										4.0	

*Restricted to Sangamon, Middle Fork, Salt Fork, Little Vermilion, and Embarrass River Basins.

† Restricted to Sangamon, Middle Fork, Salt Fork, and Embarrass River Basins.

‡ Restricted to Middle Fork, Salt Fork, and Embarrass River Basins.

§ Restricted to Sangamon River Basin.

¶ Restricted to Middle Fork River Basin.

TABLE VIII. MISCELLANEOUS FISHES—AVERAGE NUMBERS PER 100 SQUARE YARDS.

Species	Drainage area of stream in square miles at point of collection										
	0.5	1	2	4	8	16	32	64	128	256	512
<i>Esox vermiculatus</i>	3.7		0.1	0.9	0.9	1.5	0.8	0.3	0.2		
<i>Fundulus notatus</i>		1.4	2.0	3.0	8.7	2.3	0.4	1.2	0.6		
<i>Aphredoderus sayanus</i> *				1.8	15.8	5.7		0.8			
<i>Labidesthes sicculus</i> †							0.1	3.2	1.2		
<i>Hiodon tergisus</i>								0.1			
<i>Anguilla chrysypa</i>								+			
<i>Dorosoma cepedianum</i>									+	0.1	
<i>Aplodinotus grunniens</i>										0.4	

* Restricted to Sangamon, Embarrass, and Kaskaskia River Basins.

† Restricted to the Salt Fork River Basin.

While each species seems to present a separate and often complex problem with regard to the precise effects of stream size on its distribution and abundance, the data make clear some relationships that are important to at least several species in common. Let it suffice, here, to state only a few of these: (1) The upstream limit for about one-third of the 74 species known in the county is the point above which a stream is reduced to a series of more or less shrunken pools during dry weather. At this point the drainage area of our streams commonly varies between 2 and 16 square miles, depending on the contour of the land, the character of the soil, and the drainage improvements. (2) Many species that habitually hide in submerged coarse aquatic vegetation, even though they show no marked preference for certain species of plants, are nevertheless limited to the distribution of the plants, which is likewise a function of stream size and physiography. (3) Certain darters and stone cats are limited to certain characteristic kinds of rocks for cover and to certain stream velocities and depths which are found only in streams dis-

charging certain volumes of water. (4) The kinds and proportions of food available to fishes in streams of different sizes vary widely, and there are parallel variations in the distribution of many fishes which are restricted to certain food materials.

As shown in Figure 6 (page 42), the number of species of fishes *per collection* increases downstream. In one way this may seem to contradict Shelford's general statement that "communities" are closer together in small streams than in large ones, but it is explicable on the basis that the comparatively few species in the headwaters are *generalized* fishes, able to live and thrive under widely varying conditions. (A fuller discussion of these headwater fishes is given in the following section.) Then, too, the plurality of species downstream is largely due to species present in small numbers, except locally, in "niches" in the "mosaic" of the aquatic environment, where they find food and shelter without competition or invasion by larger, more numerous, or more generally distributed kinds.

The graph in Figure 6 also shows that the actual number of fishes *per unit area* decreases downstream. But with this decrease of number of fishes downstream there is a corresponding increase in the average size of the individuals, so that, other factors being equal, the total amount of fish flesh per unit area is probably almost constant. This apparent constancy of the amount of fish flesh per unit area is a fact of practical importance and is readily applicable to many fisheries problems, but it is also not without its philosophical interest. The life of streams is ultimately made up of rain water and non-living nutritive substances derived from the soil. This prospectively-living material is "crystallized out" in the form of bacteria and other lower forms of plant life, very much as a salt is crystallized out of a supersaturated solution when the process is started by the addition of a crystal of the salt; and this "crystallization" goes on until an equilibrium is established. The bacteria and other lower forms of plant life which are nourished by non-living material are the beginning of a long chain of organisms, each feeding on the one before, and their interrelations approaching an equilibrium. Fishes commonly are the end of this food chain in water. The efficiency with which each stage in the chain utilizes the preceding one varies widely. The bacteria and other lower forms of plant life probably are efficient in utilizing non-living nutritive material, and they in turn are apparently utilized efficiently by the common plankton organisms, but beyond this point a discrepancy arises. Some determinations made by Mr. R. E. Richardson, on the relation of the fish yield of Rock River to the yield of plankton there, have showed that the fish yield represented the efficient utilization of only a fraction of one per cent of the available plankton, although comparison of careful and detailed quantitative determinations of the yield of the small bottom animals upon which most fishes feed with the yield of fishes shows no large discrepancy. The greatest inefficiency, or discrepancy, is undoubtedly between the plankton and the small bottom animals. For the latter can take only such plankton as comes to them on the bottom; they cannot forage in the plankton-laden water flowing by overhead. Obviously, what is needed to make our streams more productive in fish is a new link in the food chain between plankton and the small bottom invertebrates.

HEADWATER FISHES

A few kinds of fishes can withstand the rigorous conditions of extreme headwaters, but these few species are abundant in numbers of individuals. These species are:

Erimyzon sucetta oblongus—Chub sucker
Catostomus commersonii—Common sucker
Camptostoma anomalum—Dough-belly
Pimephales notatus—Blunt-nosed minnow
Scotilus atromaculatus—Horned dace
Ericymba buccata—Silver-mouthed minnow
Abramis crysoleucas—Golden shiner
Ameiurus melas—Black bullhead

These fishes must withstand water temperatures in summer up to and exceeding 90°F. while living in pools so shrunk that the fish population is more than 10 times ordinary concentrations. In summer and early autumn they must withstand wide daily variations in temperature. In winter their ambient medium is largely converted into ice. In both winter and summer they may be called upon to endure lack of oxygen, excess of carbon dioxide, or extremes in hydrogen-ion concentration. At any season there may be torrential rains or sudden thaws that can in a single hour change their environment from a hot, stagnant pool or ice-covered ditch to a flood of muddy trash-laden water or a temporary pond in a field. When the water subsides, all the old landmarks may be gone, or the channel may have been shifted or filled up or cut deeper. Most other fishes, if called upon to meet such a crisis in the dead of winter with the water temperature at freezing, would be so torpid and sluggish in their movements that they would either be washed tail-first downstream or else be left stranded in some cornfield when the flood subsided.

The supply of animal food for headwater fishes is probably haphazard at best and depends largely on terrestrial insects which fall into the water in summer and on worms, insect larvae, etc., washed in by rains. In headwaters plankton has not had time to develop and very few kinds and scanty numbers of invertebrates are apparently able to withstand the conditions. All of these fishes seem to have solved the food question by having a very generalized diet. They all eat vegetation, organic debris, or bottom ooze probably as occasion demands, and animal food when they can get it, for none of them will refuse a bit of worm in an aquarium or on a tiny hook.

These are generalized fishes, apparently capable of meeting all situations and reaching large numbers under conditions more rigorous than others can endure. They are generalized morphologically and have a wide range of physiological adaptability. They are found over a wider range of freshwater habitats than other fishes. They not only tolerate pollution but in sizable streams can reach large numbers to the exclusion of other species where pollution is moderate.

Morphological adaptation, degree of isolation, tolerance to pollution, and other phases of the biology of these fishes are discussed in other sections of this paper.

RELATION OF SOIL FERTILITY TO GROWTH
AND ABUNDANCE OF FISHES

This study was undertaken and carried on with the rather well founded assumption that the streams of Champaign County offer an unusual degree of uniformity of conditions. The data on abundance and size of fishes, however, show a wide divergence between Spoon River, or the East Branch of the Salt Fork, and the rest of the county. The greater concentration of fishes found in Spoon River was not due to a lower stage of water there than in the other streams: for all of the 16 collections in this stream were made at about an average stage of water and were distributed as follows: 5 in July, 4 in August, and 7 in September. The total area covered in these collections was 817 square yards, about 8 percent of the total area covered in our quantitative collections throughout the county. The number of fishes taken from these 817 square yards was 4,566, or more than 5 per square yard as against the average of 3 fishes per square yard for the whole county. Thus, on an average, fishes were twice as numerous here as in the county as a whole. Again, the total weight of the fishes taken from this stream was about 110 pounds, or 37 percent of the total weight taken in the county, although the number of individuals was only 16 percent of the total number taken. That is, the individual fishes averaged from 2 to 3 times as heavy here as in the county as a whole. A comparison of the average number of fishes per 100 square yards at various points on the East Branch of the Salt Fork and its tributaries with average numbers at similar points for the county as a whole (except the polluted part of the Salt Fork, where fishes are very scanty) is shown in Table IX.

The 34 species taken in the East Branch of the Salt Fork constitute a list somewhat longer than from similar numbers of collections in other streams of the same size-range in the county. The greater number of specimens taken seems to account satisfactorily for the longer list of species. A comparison of the average number of species per collection in this stream and in the county as a whole is given in Table X.

It is interesting to see to what extent each of the different species contributed to the increased number and size of fishes in this area. Of the 34 species found in this stream, 25 occurred in abundances greater than the average for the county as a whole, and 20 of the latter in abundances greater than twice the average for the county as a whole. The silver-mouthed minnow, *Ericymba buccata*, exhibited the greatest numerical preponderance over the average for the county, contributing 1,480 of the 3,519 specimens of this species taken in the county. This preponderance is readily explained by its preference for a sandy bottom of which this stream has much larger areas than are to be found elsewhere. The horned dace, *Scmotilus atromaculatus*, here furnished 940 out of its total 2,873 taken in the county, and the Johnny darter, *Bolcosoma camurum*, 309 out of 993. It should be noted that none of the species of *Notropis* were more abundant here than the average for the county at large.

The increase of the total weight of fishes in this stream is even more notable than the increase in numbers, being 4 to 5 times the aver-

age for the county as a whole. The greatest increase in this weight was shown by the black sucker, *Catostomus commersonii*, which was not only $3\frac{1}{2}$ times as abundant here as in the county at large, but also averaged about three times as large individually. The average size of a number of other species is obviously greater than in other streams.

The larger number and the larger size of fishes in this area indicate that the conditions for survival and growth are more favorable here, and it seems most probable that an increased food supply is the cause. An examination of the stomach contents of a number of the black suckers, *Catostomus commersonii*, showed quantities of blackish mud and

TABLE IX. ABUNDANCE OF FISHES IN RELATION TO SOIL FERTILITY.

(Numbers per 100 square yards of water)

Stream size (drainage area in sq. mi.).	Number of collections.	Average of all Champaign County col- lections except polluted part of Salt Fork.	Average of collections in polluted part of Salt Fork (Disposal Plant to County Line).	Average of collections in East Branch of the Salt Fork where the soil is very fertile.
0.5	5	1419		2840
1	5	880		1732
2	7	160		
4	21	545		1228
8	22	429		953
16	15	413		1571
32	19	346		540
64	7	270	11	915
128	11	323	*	471
256	6	208	30†	
512				

* Two collections taken in this region give an average of 238 per 100 sq. yds. They are omitted because 92% of this number are of three tolerant headwater species which were evidently feeding here on an immense growth of diatoms and blue-green algae which extended from the mouth of the East Branch downstream for about five miles. Sixty-two per cent of the total number making up these two collections were taken at a single dip of the net in a small deep hole away from the main channel.

† This number is based on four collections made from Sidney down to the County Line, but does not include a collection made just below the Homer Dam, with 254 per hundred sq. yds., which would have brought the average up to 75 per 100 sq. yds. The latter collection is omitted because it yielded a number of species unusual to this part of this stream and because Richardson has shown that swift water offers unusual protection to otherwise sensitive forms.

ooze and little else. In this stream there were considerable amounts of a variety of aquatic vegetation, perhaps no greater than are to be found in other parts of the Salt Fork or in other streams, but of kinds better adapted for supporting an abundance of animal food for fishes. Collections of the small bottom animals, while not quantitative, indicated a much larger supply of fish food.

An inquiry addressed to Mr. E. A. Norton, of the Soil Survey, brought the information that the soil of this region was unusually fertile in plant foods, produced superior crop yields, and had a very different history from soils in the remainder of the county. This has been discussed earlier (page 7).

The abundance of fishes in this stream is apparently reflected in the fact that we took more adult snapping turtles, *Chelydra serpentina*, in this stream than in all the rest of the county combined. This is significant because the snapping turtle is almost, if not entirely, piscivorous in its habit.

Champaign County is near the center of an area of several counties in which the soil is more fertile than in other parts of the state. This area, as outlined by Mr. Norton, is shown in Figure 2. From it streams flow outward in different directions—the Kaskaskia and Embarrass to the south, the Sangamon and Mackinaw to the west, the Vermilion (a branch of the Illinois) and the Iroquois to the north, and the Big Vermilion and the Little Vermilion (branches of the Wabash) to the east. A casual examination of the distribution maps of Illinois fishes as given in the atlas accompanying the volume by Forbes and Richardson (1909) shows a decided preponderance of occurrences in this fertile area. A small part of this preponderance may conceivably be explained by greater numbers of collections in this area, but even so the occurrences are still more numerous in this area. Moreover, as we have just seen earlier in this section, if the number of occurrences is greater, the actual number and size of fishes is greater still. It is interesting to note that the 25 species of fishes which occurred in the East Branch of the Salt Fork in numbers greater than the average for the county are the *same species* which show unusually high percentages of occurrences in this unusually fertile general area as compared to the figures for the state as a whole.

EFFECTS OF POLLUTION ON GROWTH, DISTRIBUTION, AND ABUNDANCE OF FISHES

When this study was begun it was known in a general way, from casual collecting during the past ten years, that certain streams in Champaign County carried pollution and that aquatic life in these streams was more or less completely altered thereby. Previous experience in aquatic work outside the county had shown that household sewage, within certain limits, acts as a fertilizer and increases the productivity of a stream, the fishes being of greater size, abundance, and variety—a result comparable to the effect of high fertility of soil just described in the East Branch of the Salt Fork. The present study shows that an excess of sewage results in decreases of number of kinds, abundance per unit area, and average size of fishes. There is no lack of fertility or of plant and

animal foods for fishes in these polluted streams, but the fishes cannot tolerate the conditions or substances that result from the sewage or its products of decomposition.

The most obvious and most important factor limiting fish life in polluted waters is the deficiency of dissolved oxygen which occurs in certain places and under certain conditions. Some work done a few years ago on the oxygen requirements of fishes of the Illinois River⁸ showed that the number and variety of kinds of fishes taken by certain uniform methods of fishing in the same area varied directly with the amount of oxygen dissolved in the water. Furthermore, this variation in relative abundance and number of kinds not only took place in response to variations in the oxygen concentration near the lethal limit but was, apparently, equally as effective near the saturation point of atmospheric oxygen in water.

It is obvious that the size of fishes in these, as well as in other small polluted streams, averages distinctly smaller than in clean streams.

TABLE X. AVERAGE NUMBERS OF SPECIES OF FISHES PER COLLECTION.

(The average number of individuals per collection was about 220.)

Stream Size (drainage area in square miles).	Number of collections.	Average of all collections except pol- luted part of Salt Fork River.	Average of polluted part of Salt Fork (Disposal Plant to — County Line).	Average of East Branch of Salt Fork, where the soil is very fertile.
0.5	5	3.8		3.0
1	5	5.0		6.5
2	7	5.0		
4	21	8.8		9.5
8	22	9.6		9.8
16	15	12.1		7.0
32	19	13.3		20.0
64	7	11.3	2.6	16.0
128	11	20.1	12.5	25.0
256	6	15.5	7.8	
512				

8. Thompson, David H. "Some Observations on the Oxygen Requirements of Fishes in the Illinois River" Ill. Nat. Hist. Surv. Bul., vol. 15 (art. 7), pp. 423-437, 1925.

In the Illinois River it has been shown that the carp average smaller in the more polluted sections,⁹ and this difference in size was found to be due to slower growth of the carp in those sections. In Champaign County streams, however, there is no evidence that the difference in size is due to slower growth; it seems somewhat more probable that the larger fishes are eliminated by low oxygen concentrations, since they have a smaller ratio of respiratory surface to body size than do small fishes.

The Salt Fork, which carries wastes from Urbana and Champaign, the largest towns in the county, is obviously polluted over a greater distance, and affords more complete information on the relation of pollution to fishes, than other streams in the county.

For comparison of the polluted and unpolluted sections of the West Branch of the Salt Fork, collections were made, at first, from approximately equal areas above and below the source of pollution, extending from the point where the stream enters Crystal Lake Park to the bridge just south of University Woods. In this distance the drainage area increases from 59 to 76 square miles, the difference being due primarily to the confluence of the Boneyard. The width, depth, rate of flow, and kind of bottom are essentially the same throughout this distance, so that the same variety of habitat is afforded above and below the source of pollution, namely: long, smoothly flowing reaches, separated by small rapids or riffles, and occasional "holes" three or more feet deep. The results of quantitative collections made from 330 and 320 square yards, respectively, above and below the source of pollution, are shown in Table XI. Other fishes known to have been taken from the stream in Crystal Lake Park during the year are indicated as "+" in this table. Most of the fishes taken below the Champaign-Urbana sewage disposal plant were about the mouths of two tile drains.

The differences in the fish life above and below the outlet of the sewage disposal plant are clearly due to conditions resulting from pollution in the lower section. The stream as it runs through Crystal Lake Park and down to the mouth of the Boneyard is typical of the clean dredge ditches of this region.

On May 10, 1928, at three points $1\frac{1}{2}$, 3, and $5\frac{1}{2}$ miles below the outlet of the plant, where the above collections of fishes from the polluted area were made, the stream had a nauseating odor perceptible on the bridges above the water. The stream was then quite low, and the weather was ordinary, warm, May weather. The rocks and other objects in the water at these three stations were covered with grayish or brownish feathery or flocculent growths. There was a large amount of light flocculent solid matter drifting in the water, sufficient to completely clog our seine when it was held in the current more than a few seconds. In the quieter places along shore and behind drifts and large objects, there were deposits of black sludge, varying from an inch to several inches in depth, which gave off a strongly putrescent odor when stirred up. Tubificid worms, which in numbers are characteristic of heavily polluted waters, were extremely abundant in the mud and sludge along the shores and also among the gravel and sand in midstream.

9. Thompson, David H. "The Knothead Carp of the Illinois River." Ill. Nat. Hist. Surv. Bul., vol. 17 (art. 8), pp. 285-320, with 14 fig. 1928.

On the riffles and in swift water there were considerable growths of two plants tolerant of pollution—*Cladophora glomerata* and *Elodea canadensis*—which, together with *Potamogeton pusillus* and one or two others, are characteristic of the coarse aquatic vegetation of polluted small streams of Illinois.

During the summer of 1928 there were heavy rains which largely flushed out the accumulations of sludge and organic matter from the stream bed, and the continuous operation of the disposal plant tended to reduce further accumulations. When collections were made in September it was expected that the stream would appear cleaner and fishes more abundant, but such was not the case. One small, blunt-nosed minnow (*Pimephales notatus*) and two very small green sunfish (*Lepomis cyanellus*) were collected from a total water area of 90 square yards in the same places in which the spring collections were made. There was no floating or drifting organic matter or sludge,

TABLE XI. EFFECTS OF POLLUTION IN THE WEST BRANCH OF THE SALT FORK.

Comparison of the kinds, numbers, and maximum sizes of fishes taken from approximately equal areas of water in the West Branch of the Salt Fork above and below the source of pollution on May 10 and 11, 1928. (See text, p. 52.)

Species	Collection from 330 square yards above source of pollution.		Collection from 320 square yards below source of pollution.	
	Number of fishes	Max. size in inches	Number of fishes	Max. size in inches
<i>Notropis whipplii</i>	+		1	1.8
<i>Pimephales notatus</i>	320	3.0	1	1.1
<i>Semotilus atromaculatus</i>	22	6.1	1	2.0
<i>Notropis umbratilis atripes</i>	71	2.5	18	2.1
<i>Ericymba buccata</i>	126	2.3	2	2.0
<i>Campostoma anomalum</i>	5	4.8		
<i>Abramis crysoleucas</i>	74	5.1		
<i>Erimyzon sucetta oblongus</i>	3	5.4		
<i>Catostomus commersonii</i>	6	9.8		
<i>Esox vermiculatus</i>	1	8.0		
<i>Lepomis megalotis</i>	12	4.3		
<i>Lepomis cyanellus</i>	7	5.1		
<i>Lepomis humilis</i>	3	2.3		
<i>Lepomis pallidus</i>	1	4.6		
<i>Boleosoma nigrum</i>	6	1.2		
<i>Notropis blennius</i>	+			
<i>Ameiurus melas</i>	+			
<i>Labidesthes sticulus</i>	+			
<i>Lepomis miniatus</i>	+			
<i>Etheostoma flabellare</i>	+			

such as was seen on May 10, and no large beds of sludge, but the sand and the mud of the bottom and banks contained a large admixture of black sludge with a putrescent odor and immense numbers of tubificid worms. The stream gave off the same nauseating odor as was noticed in May. The water was unusually clear for a stream in this region, possibly from the lack of fishes that tend to stir up the sediment and bottom muds, or else because of the agglutination and precipitation of the silt by the abundance of microscopic organisms poured in by the disposal plant. Downstream from the disposal plant outlet to a point several miles below St. Joseph, there was a heavy growth of brown diatoms; and for several miles below the confluence of the East Branch of the Salt Fork, there were heavy growths of blue-green algae along with the diatoms.

Collections made in September, 1928, from the West Branch and the East Branch, at stations $1\frac{1}{2}$ miles above their confluence, yielded in the West Branch 30 fishes, taken from about 105 square yards, all of them belonging to four known tolerant kinds and having a total weight of about three ounces—as against 437 fishes, of 25 kinds, taken from 90 square yards in the East Branch and having a total weight of about 15 pounds.

In January, 1926, when the sewage disposal plant had been in operation about a year, a collection of fishes was made in the West Branch of the Salt Fork at the bridge just south of University Woods at the same place where the collections were made in the spring and fall of 1928. At this time fishes were clearly more numerous than they were found at any time in 1928. The number of kinds and the maximum size were greater, and specimens were taken of the Johnny darter, a species that has not been found since in the polluted section of the West Branch, although it is more tolerant than other darters. The 1926 data, though fragmentary, at least make it clear that four years of operation of the sewage disposal plant have had no greater effect than one year in cleaning up the stream.¹⁰

Dr. T. H. Frison reports that, in the years 1912 to 1914, sunfish, bullheads, and suckers could be taken in fair numbers on hook and line from the West Branch of the Salt Fork near the University Woods.

Collections made by the Natural History Survey in the West Branch of the Salt Fork in the period 1882-1901 showed a number of species not found in the 1928 collections, even though the latter collections were twice as numerous. In the older collections the white crappie and the large-mouth black bass were taken, probably because they were planted or had escaped from a fish hatchery which was then in operation in Urbana. Besides these, the spotted sucker, common red-horse, sucker-mouthed minnow, top minnow, brook silverside, and black-sided darter have since disappeared, even from the stream above the source of pollution. It so happens that the stream above the source of pollution is just at the upper limit of stream size in which all of them live, except perhaps the last named; and since the stream below Urbana has become heavily polluted, they apparently have not been able to exist and maintain their numbers cut off from the lower course of the stream.

10. In the past two years the plant has been operated continuously, and new units have been added which tend to reduce further the organic load of the stream. A few cursory examinations made recently reflect these improvements, there being a somewhat greater variety and greater numbers of fishes, particularly in the lower course of the stream.—D. H. T. July 1, 1930.

Collections of bottom fauna and plankton were made in the West Branch near the University Woods in May, 1929, and were identified in the laboratory by Mr. Richardson. The bottom fauna collections were made from clumps of *Elodea canadensis* growing in midstream and from gravel and sand there. The most numerous animals taken from these were two species of sludge worms, or Tubificidae. *Limnodrilus hoffmeisteri* and *Tubifex tubifex*, which occurred in roughly 100 times the numbers to be expected in ordinarily clean streams with gravel and sand bottom. The presence of these sludge worms in such numbers is indicative of a heavy load of organic matter in the water and, in general, conditions which are distinctly polluttional. Small numbers of several other species of small bottom animals also occurred in these collections, but their value as indices of pollution has not been sufficiently studied. One other thing was noticed which invariably indicates foul conditions—the larvae of the sewage fly, *Psychoda alternata*. Furthermore, other insect larvae found here were covered with colonial vorticellid protozoans of the genus *Epistylis*. In unpolluted streams the insect larvae and other small bottom animals are habitually clean and free from incrusting micro-organisms. The plankton sample taken here showed *Epistylis*, *Thiothrix*, and *Rotifer tardus*, all of which were probably washed down directly from the sprinkling filter bed of the sewage disposal plant.

Determinations of the amount of dissolved oxygen in the polluted section of the Salt Fork, made at various times during the past two or three years, showed amounts varying from saturation down to 3 or 4 parts per million. In those cases where a series of samples were taken on the same day at different points on the stream the samples showing least dissolved oxygen were taken near the outlet of the plant. Duplicate samples taken on January 17, 1929, at a point $1\frac{1}{2}$ miles below the plant, showed a biological oxygen demand of 51 and 56 parts per million. At that time the plant was discharging at the rate of 2,700,000 gallons per day, and the effluent was diluted to 6 times that volume by the water in the stream.

Occasional periods of oxygen deficiency are usually regarded as the immediate cause of destruction of fishes by pollution. Evidence of this came to hand in November, 1928, during other studies along the West Branch of the Salt Fork from the bridge east of the Tuberculosis Sanatorium down to Brownfield Woods, points respectively $1\frac{1}{2}$ miles and 3 miles below the sewage disposal plant. In the early part of the month the stream had been low and there were considerable accumulations of sludge and putrescing organic matter along the shore and in the quieter places. On the 14th and 15th of November, as a result of rains, the water level rose and the sludge and organic matter were stirred up. At this time the stream was black, smelled strongly putrescent, and had the appearance of being septic. On the 16th and 17th the stream had subsided and resumed its customary aspect. On these days several small fishes were picked up freshly dead; they were faded and had their mouths agape and their opercles and branchio-stegals extended, showing evidence of suffocation. Since lack of oxygen is the only well-known means by which pollution has its effect on fishes, it seems that lack of oxygen must be at least the tentative explanation of the absence of fishes in this stream.

The West Branch of the Salt Fork from the sewage disposal plant down to its confluence with the East Branch receives no tributaries other than a few tile drains. In this stretch of about 12 miles the condition obviously improves, fishes become more numerous, of more kinds, with greater maximum size; and the deposits of sludge, the nauseating odor, and the other evidences of pollution decrease. It seems quite certain that this improvement in the stream without much dilution is due to the continuance and completion of biological processes of self-purification.

A collection made in September, 1928, about 2 miles below the confluence of the East Branch and West Branch of the Salt Fork, showed fishes in normal numbers, but 98 percent of them were of known tolerant kinds, 92 percent being blunt-nosed minnows, silver-mouthed minnows, and steel-colored minnows, which were feeding on the very heavy development of diatoms and blue-green algae at this point. From Sidney down to the county line, fishes occurred in about one-seventh of the numbers normal to streams of this size. Apparently normal numbers and kinds of fishes were taken just below the Homer Dam, but Richardson (1928) has shown that swift water, in general, offers unusual protection to species otherwise sensitive to pollution.

During the period 1919 to 1924, *i. e.*, before the sewage disposal plant was put in operation, the writer collected fishes from time to time in the two-mile stretch above the Homer Dam. Fishes taken then included green sunfish, long-eared sunfish, suckers, bullheads, and several kinds of minnows. When those collections are compared with collections made in the same place in 1928, no obvious increase in fishes is apparent, although several car-loads of fishes have been planted there since the disposal plant was put in operation. There are reports of crappies, carp, channel cat, bullheads, and many sunfish being taken above the Homer Dam in 1916.

The number of species of fishes and the abundance of each in the polluted part of the Salt Fork, as compared with other streams of the county, are shown in Tables IX and X.

The following list of fishes, arranged in order of decreasing tolerance to pollution in small streams, is based on observations in this and other streams of comparable size:

Semotilus atromaculatus
Pimephales notatus
Notropis umbratilis atripes
Ericymba buccata
Notropis whipplii
Abramis crysoleucas
Lepomis cyanellus
Boleosoma nigrum
Campostoma anomalum
Erismyzon sucetta oblongus
Catostomus commersonii
Notropis cornutus
Hybopsis kentuckiensis
Notropis blennioides

The darters other than the Johnny darter seem to be most sensitive to pollution. Almost all of these tolerant species find their greatest development in headwater streams. These headwater species occur in polluted large streams where they normally would not occur in such numbers were the stream clean.

The Boneyard, a small creek flowing through Champaign and Urbana and emptying into the West Branch of the Salt Fork about a half-mile above the outlet of the sewage disposal plant, has been badly polluted with a miscellany of household and industrial wastes including oils, gas liquors, tar, soap suds, rubbish, garbage, precipitates from water-softening processes, drainage water from the streets, etc. This stream is practically without fish, there having been reported within the past few years a medium-sized black sucker, three or four very small chub suckers, and a school of about a dozen small minnows. The effect of the Boneyard water on the fishes of the stream below was not separated from the effect of the effluent of the disposal plant in the present study.

Copper Slough, a branch of the Kaskaskia, receives untreated sewage from the west part of the city of Champaign and is thereby so grossly polluted for several miles down from its source that there was no fish life at all in August, 1928, and even in its lower course there were very reduced numbers of fishes. Dr. T. H. Frison reports that some years ago black bullheads and horny-head chubs could be taken where Route 10 now crosses Copper Slough.

Sewage from the village of Rantoul flows eastward about two miles in a ditch alongside the highway and empties into the East Branch of the Salt Fork. It was noticed at the time of our first visit, in July, that the ditch coming from the town (carrying undiluted sewage) stank badly and was black with sludge, and that grayish growths of pollutional protozoans or schizomycetes were abundant. The weather just then was very warm, and by the time the sewage had reached the stream the putrefactive processes were evidently nearly complete; for the stream below the mouth of this ditch was not septic, although there were extensive deposits of sludge and an obvious scarcity of the bottom animals ordinarily found in clean streams. Fishes were abundant in the stream below the mouth of the ditch, a quantitative collection made there showing 1,866 per 100 square yards—a figure which compares well with abundance figure for other headwater streams feeding the East Branch of the Salt Fork. It should be mentioned, however, that 94 per cent of the fishes in this collection were of known tolerant kinds. The same place was visited again in November after the weather had been near freezing for some days. Although the water level in the ditch and in the stream was at approximately the same stage as in July, the coolness had retarded the putrefactive processes so that they were, apparently, only well under way by the time the stream was reached; for the stream itself was stinking and septic and entirely without fishes for $1\frac{1}{2}$ miles below the mouth of the ditch.

A few years ago many fishes were killed in a tributary of the Sangamon as the result of pollution by wastes from a canning factory near Gibson City.

OTHER ENVIRONMENTAL FACTORS AFFECTING DISTRIBUTION AND ABUNDANCE

Vegetation is a factor determining the abundance of most small-stream fishes. The largest variety and greatest abundance of fishes in individual collections were consistently found in situations with luxuriant growths of submerged coarse aquatic plants. The large number of fishes in such places is certainly correlated with the large populations of food organisms which these plants support. The presence or absence of certain species, such as the pirate-perch, the golden shiner, and the grass pike, is closely associated with the presence or absence of aquatic vegetation.

Depth of water is an important factor in the distribution of many fishes. The buffalo fishes, carp-suckers, gizzard shad, sheepshead, and several of the sunfishes are found only in the deeper pools. Others, such as the long-eared sunfish, may occur in a stream of any size in the county providing that the water is a foot or more in depth. In general, adult fishes seek deeper water than young fishes, and large species more than small species.

Kind of bottom and rate of flow of streams in Illinois generally are casually related, and it is difficult to differentiate the effects of these two factors on the distribution of fishes. Some species are obviously more abundant on certain kinds of bottom than on others, and a few are very strictly limited to certain substrates, as is described in various places in this paper. Our present data do not permit a critical comparison of total abundances of fishes on different kinds of bottom, and no obvious consistent differences were apparent during the course of the field work.

EFFECT OF FISH-EATING SPECIES ON ABUNDANCE

The general decrease in number of fishes and increase in size of individual fishes as we pass from the smaller to the larger streams may be due, at least in part, to the larger number of fish-eating kinds in the larger streams, such as the large-mouth and small-mouth black bass and the channel cat. Our numbers of these kinds are too small to make a statistical comparison. One of the most voracious of the typically small-stream fishes is the grass pike. Excluding collections from the polluted part of the Salt Fork, our 26 collections in which the grass pike occurred averaged 2.49 fishes per square yard; and the remaining 86 collections, in which the grass pike did not occur, averaged 5.71 fishes per square yard—more than twice as many. The number of grass pike producing this effect was quite small, averaging only 0.006 per square yard. This relatively large effect of so few grass pike is understandable, however, because we have aquarium experiments which show that a grass pike of average size can eat about one minnow per day.

SOME OBSERVATIONS ON MORPHOLOGICAL ADAPTATIONS

Since the beginning of the science of biology, close organic correlation of the various parts and internal functions of an organism during its life history has been so apparent and so exact that workers in this field are much given to teleological explanations of these phenomena.

Workers investigating the relations of organisms to their surroundings are much more impressed by the similarity of the reactions of the different organisms in a given environment than by the similarity of morphological adaptations found there. In this they are doubtlessly correct. Morphological adaptation, however, should not be neglected or put aside as unimportant.

Among the small-stream fishes of Champaign County it has been found that there is a readily recognizable and fairly close correspondence between habit and structural adaptation, although there are many exceptions. Non-adaptive structures, incongruities, elaborateness, and uniformity of detailed structure are certainly not necessary from the standpoint of the requirements of the environment; nevertheless, they are the rule within the various races of animals and are intimately tied up with the fundamental nature of living substance itself. The relative importance of physiological as against morphological adaptations is a dilemma that has been considerably clarified by recent findings in the study of the manner of inheritance of the characteristics of living things. It has been found that many morphological changes are *inseparably associated* with certain physiological qualities. It so happens that the morphological changes are usually of trivial importance from the standpoint of viability and usually involve such things as proportion of parts, texture, color pattern, etc. The associated physiological qualities, on the other hand, commonly involve such important things as number of eggs, length of life, rate of development, viability at all stages, reactions to stimuli, etc. If both the physiological and morphological changes are of advantage they will survive. If both are disadvantageous they will not survive. However, if one is advantageous and the other disadvantageous the one will survive which has the greater selective value at critical points in the life history, and the other will be carried along willy-nilly because it is inseparably associated, even though it is unnecessary or even somewhat disadvantageous. The fact that hereditary changes usually involve selective differences which are more often physiological than morphological, gives a hint as to why animals show a better physiological than morphological closeness-of-fit to the environment.

The fishes of Champaign County fall into three approximately equal groups with respect to current: (1) Those that live in the faster, shallower water and spend most of their time, not swimming, but clinging to the bottom or hiding behind or under objects which break the force of the current. (2) Those that live in deeper and more sluggishly moving water and spend most of their time swimming or floating but not clinging or hiding. (3) Those that inhabit both kinds of places and divide their time between clinging or hiding and swimming freely. As these three groups of fishes are examined, certain morphological features stand out as characteristic of each group.

The first group—"clinging" fishes—is typified by the hog sucker, the darters, the red horses, the stone cats, and the tadpole cats. They have a large head and a body that tapers from the head to the tail and is roughly circular in cross-section; that is, they are slenderly conical. They have large pectoral fins with which they cling or "crawl" on the bottom. Their specific gravity is greater than that of other fishes. They often show protective coloration by having their backs crossed by dark bars.

The second group—"swimming" fishes—is typified by the gizzard shad, the toothed herring, the sunfishes, and certain minnows such as *Notropis cornutus*, *N. umbratilis*, and *N. whippelii*. These fishes are flattened laterally and tend to taper equally toward the head and tail from the middle of the body. Their swimming habits are correlated with large caudal fins and a specific gravity almost exactly the same as water. These are the fishes that leap from the water. Adults of several other species have the body shape and swimming habit of this group, but their young live in fast water and have the body shape typical of the first group. An excellent example of such a change in body shape and habit is found in the silver carp, *Carpoides velifer*.

The third group—"generalized" fishes—has a body form typified by the extreme headwater fishes, such as the blunt-nosed minnow, the horned dace, the chub sucker, and the dough-belly. These fishes tend to be circular in cross-section and to taper from the middle toward both ends. They are commonly found in both still and fast water.

While there are many exceptions in one way or another to the above classification, it still holds for most of the local fishes.

There are other local examples of structural adaptation correlated with certain habits. Fishes that regularly feed from the surface, such as the silverside (*Labidesthes sicculus*) and the top minnow (*Fundulus notatus*), have flat backs and upturned mouths. Larger fishes that habitually live under flat rocks, such as the stone cat (*Noturus flavus*), are dorso-ventrally flattened. Fishes that nuzzle the bottom and pry among rocks for food, such as the various suckers and the sucker-mouthed minnow (and elsewhere the sturgeons), have inferior, protrusible mouths. There are three species of one genus (*Ictiobus*) which are bottom feeders but have differently formed mouths: the small-mouth buffalo has a strictly inferior mouth, the mongrel buffalo has a mouth tilted up at about 22° from the horizontal, and the red-mouth buffalo has its mouth turned up at an angle of 45° . In late summer large numbers of red-mouth buffalo have been seen sucking in the foam and floating insects in the quieter eddies of Rock River, but never a mongrel or a small-mouth buffalo. This observation is amply borne out by recent studies of the stomach contents of these three species.

MIGRATION, ISOLATION, AND CHANGES IN DISTRIBUTION

The extremes of fish migration are represented by fishes taken in Champaign County. As one extreme, there is the eel taken in the Embarrass River, which must have been spawned in the Sargasso Sea off the coast of the Bermuda Islands, according to recent life-history work on this species. As the other extreme, we have darters that live under the rocks on riffles and may not have moved more than a few hundred yards in many generations.¹¹ The migration of most of our species, however, is moderate.

11. A good instance exemplifying this sedentary habit came out during our work on the Rock River. In 1927, after four years of collecting in the Rock River basin, it seemed that our list of fishes was complete, at least for the basin in Illinois. I went to see two old fishermen, brothers by the name of McMillan, who had made most of their living since boyhood by fishing one way or another in the vicinity of Rockford. In order to facilitate conversation and avoid difficulties of different common names for the same fish and the same common name for different fishes, I took along the Survey's illustrated volume on the fishes of Illinois. We

We have sufficient information to show migration for eight species of suckers, the young of each of these species being regularly taken much further upstream than the adults. As an example, the young of the common red-horse were found most abundantly in streams draining 4 to 8 square miles, while the adults are known to reach their greatest abundance in streams draining 1,000 or more square miles, *i. e.*, much larger than any in Champaign County. The toothed herring and the gizzard shad probably make migrations of about the same order in larger streams, and the larger members of the sunfish family are probably capable of extended migration, although our data do not directly indicate this. Among the minnows there are no clear examples of different distribution of the young and the adults in our streams, but a certain amount of migration is indicated by the fact that headwater minnows are regularly found in spring in small rivulets which at other seasons dry up completely for one or more miles. None of our seven species of catfishes gave evidence of any considerable migrations.

During 1928 and 1929, several anglers fishing in the Sangamon River, both in Champaign County and Piatt County, have expressed surprise at taking sheepshead in fair numbers, a kind of fish which they report had not been seen in the Sangamon before. This suggestion that the sheepshead is a newcomer is substantiated by our findings. We took ten specimens in the Sangamon within the county in 1928. Earlier collections by the Survey did not take the sheepshead from the Sangamon, either in this county or any place else along its entire length, although this species was taken in the Illinois River and in several other streams in the state. The specimens taken or seen in 1928 all weighed between 3 and 6 ounces—the same size, incidentally, at which the sheepshead have been observed in thousands in May below dams on the Rock River and below the head-gates of the Illinois-Mississippi Canal Feeder, attempting to go upstream. The fact that the collections and reports of sheepshead in the Sangamon in 1928 and 1929 are scattered over fifty miles or more of stream, argues that these fishes have migrated upstream from some point further down, rather than that they have been planted locally in many places.

leafed through the book together, meanwhile checking the fishes they had seen in the vicinity against my species list for the river. I pointed to the picture of the sculpin (*Cottus bairdii*) and remarked that they probably had not seen it because we had not taken it in our extensive program of collecting in the basin. The older brother spoke up and said, "Yes, that's a **doogy pawl**. I call it that because it looks like a fish by that name I used to catch when I was a boy in Scotland." He went on to relate that for many years they had made a business of catching minnows for the bait market in the small streams about Rockford and that there used to be one place, and one place only, where they found the sculpin. This place was in a small stream tributary to Sarver Creek, about seven miles northwest of Rockford. They had first noticed it there some 15 or 20 years previously, and they had not been to the place for the past several years. The younger brother agreed to go with us next day and point out the place. When we arrived, there was a rocky riffle about 10 feet long in a tiny stream in a pasture. We set our minnow net below the riffle, rolled some of the rocks over, and lifted out 3 or 4 sculpins. Then we seined just above the riffle, but got none. We seined below the riffle and took five or six more sculpins. A few yards further down we took none. Then we went on and seined over several hundred yards but found none. Persistently we seined in the vicinity of every bridge over this whole tiny stream system, but no sculpins. For several weeks as we worked over the small streams of that part of the Rock River basin, we tried every likely riffle, many of which were identical with the sculpin riffle, but nowhere did we find another sculpin. When our sculpins were compared with others of the same species collected in Indiana, they were found to differ in several minor details of body contour and minute structure. While the sculpin is in a different family of fishes from the darters, it is of about the same size and in point of shape and habit can best be described as an exaggerated darter.

There is another kind of migration that applies to all our larger fishes in Illinois streams and probably also to smaller kinds. In spring, summer, and early autumn the larger fishes are found in all parts of the larger streams; some are in fast water, some in smoothly flowing reaches, some hiding among brush and vegetation, and some in the deep pools of quiet water. As the water becomes cold with the approach of winter, these fishes become sluggish and stop feeding, then retreat downstream and join the fishes of the deep pools. In spring when the ice is gone and the water is warmer, they ascend the stream and begin feeding. Our investigations on Rock River have shown that the order in which the different fishes come into the quiet pools and eddies is quite definite and that the order in which they go out is the reverse of the order in which they come in. Furthermore, those that come in first are generally sluggish-water fishes; next are those of moderate current; and last are those of the swift waters, such as the red-horses and the common sucker. In Rock River the wall-eyed pike may or may not retreat from the fast water during winter. This pike is very active in its movements all winter and feeds voraciously and is taken on the hook in swift water every month in the year. The fishes soonest benumbed are those that live in summer in the deep pools, such as the blunt-nosed river carp, the sheepshead, the buffalo fishes, the quillback, the carp, and the gizzard shad. The last-named fish seems particularly susceptible to cold, being seriously winter-killed.

Fishes in the headwaters of the Salt Fork are but two or three miles overland from fishes in the headwaters of the Sangamon, but as a fish travels they are more than 1,200 miles apart. Such long distances, doubtlessly, are traversed in a reasonable period of years by the larger, abler, and habitually swimming species. The uniformity in contour, color pattern, and morphological detail within such strong swimming species as the suckers and the larger sunfishes bears witness to frequent interbreeding within the species and lack of isolation. On the other hand, minnows, darters, and small species of other groups with feeble swimming powers and with a tendency to spend most of their time in restricted habitats, such as under and around stones, among vegetation or other cover, small eddies below riffles, etc., may be effectively isolated for very long periods of time, especially if they are in different streams and separated by many miles of water. Even in the same stream their distribution is "spotty" because they are sedentary or are adapted to limited kinds of habitat.

It may be possible, however, for some fishes to pass from one basin to another, in such flat country as we have in Champaign County, during prolonged periods of extremely wet weather. This is indicated in the state distribution of the silver-mouthed minnow (*Ericymba buccata*). That this minnow should pass from one basin to another is not at all surprising, since we have already shown that it is an extreme headwater species and will even ascend tile drains. The present data indicate that interbasin passing does not occur unless it be among the extreme headwater species. Among the isolated species in general, there is no evidence of any extended migration during the spawning period.

Among families of small fishes, ichthyologists have found local races and varieties to be the rule. Among freshwater fishes commonly inhabiting headwaters and other out-of-the-way "niches" in the environment, inordinately large numbers of species and varieties of minnows and darters are recognized. While our Champaign County collections have not yet been thoroughly studied with this in view, racial differences in morphological detail have been found, as will be fully reported in a later paper. Several of these differences may be mentioned here: (1) The fan-tail darter in Champaign County is restricted to the Sangamon, Salt Fork, and Middle Fork basins. Sixteen specimens from the Sangamon and its tributaries each had 8 dorsal spines. Of 7 specimens from the East Branch of the Salt Fork, four had 8 spines and three had 7 spines. Nine specimens from the Middle Fork and its tributaries each had 7 spines. (2) The log perch taken in the Kaskaskia Basin have a color pattern distinctly different from those taken from the Middle Fork Basin. (3) The orange-spotted sunfishes of the Sangamon have a body shape which differs markedly from those of the Salt Fork. (4) Within certain small species there seem to be consistent differences in the numbers of vertebrae between different stream systems.

A casual survey of the literature on geographical races among motile animals gives the impression that isolation is a more effective cause of racial differences within a species than is a difference in environment to which an animal may respond directly in one generation or be gradually adapted over many generations. If this be true, the explanation of geographical races is to be sought in terms of the properties of the germplasm and of the growth of populations rather than in terms of the response of the organism to the environment. Every species that has been studied genetically has shown heritable variations of greater or less degree. Furthermore, these heritable variations are continually arising *de novo* by changes in the germplasm due to causes entirely unrelated, as far as is known, to ordinary variations in the physical environment. While most of these heritable variations are disadvantageous to the animal and are rapidly eliminated, many of them are of indifferent selective value and may persist. Yet it is a significant fact that no heritable variations have been found which are more viable and can crowd out the "wild type." This superlative position of the "wild type" suggests that it represents the highest possible combination of hereditary factors affecting viability, and if so, variations in viability can occur only in the downward direction.

It is common experience that a population of a species is at all times heterogeneous, its degree of heterogeneity being dependent primarily on the rate of origin of variations *de novo* as compared with the rate of their elimination due to selectivity and the degree of inbreeding. The degree of inbreeding is important because it is a common fact of all population studies that the population of a species within an isolated area at any one time is not descended from the entire population of that species in that area, let us say several generations earlier, but from a fraction of it. If, in any generation, by chance, the parents of the next generation are all homogeneous for some indifferently selective, heritable variation which has arisen *de novo*, then the character of the

whole population will have been changed without regard to the selective value of the variations or environmental differences. Since these heritable changes arising *de novo* are fixed in populations by *chance*, the probability is infinitely small that the same changes will arise and be fixed in isolated populations. Hence, as long as populations are isolated, heritable differences from the original condition, and from each other, will accumulate. If, however, interbreeding is occasionally possible between partially isolated populations, their differences will tend to be ironed out, likewise, by *chance*.

Of the 74 species taken within the county, there are 17 which have been collected in sufficient numbers to avoid errors due to random sampling and which are absent from one or more of the six stream systems. Furthermore, these 17 kinds include *only* those species whose *preferred habitat and stream size* are known to occur generally in the streams from which they are absent. These species are listed below, together with the stream systems in which they have been taken.

<i>Species</i>	<i>Stream Systems</i>
<i>Pimephales promelas</i>	Sangamon
<i>Hybognathus nuchalis</i>	Kaskaskia
<i>Notropis gilberti</i>	Sangamon
<i>Notropis atherinoides</i> var.....	Middle Fork
<i>Notropis illecebrosus</i>	Middle Fork
<i>Hybopsis amblops</i>	Middle Fork, Salt Fork, Embarrass
<i>Cliola vigilax</i>	Sangamon, Salt Fork
<i>Schilbeodes gyrinus</i>	Salt Fork
<i>Schilbeodes miurus</i>	Salt Fork
<i>Lepomis humilis</i>	Sangamon, Middle Fork, Salt Fork, Embarrass
<i>Aphredoderus sayanus</i>	Sangamon, Embarrass, Kaskaskia
<i>Labidesthes sicculus</i>	Salt Fork
<i>Etheostoma coeruleum</i>	All but the Kaskaskia
<i>Etheostoma flabellare</i>	Sangamon, Middle Fork, Salt Fork
<i>Etheostoma zonale</i>	Sangamon
<i>Diplesion blennioides</i>	Middle Fork, Salt Fork, Embarrass
<i>Ammocrypta pellucida</i>	Middle Fork

As these fishes are examined to see what they have in common, we find, first, that they are all small, the largest specimen among them being a *Hybognathus nuchalis* 3 $\frac{1}{4}$ inches long. More than half of them are clearly sedentary in habit and spend most of their time hiding. All of them are specialized physiologically, since they are restricted to special kinds of habitats which are usually of discontinuous distribution. Our findings on these fishes correspond, both in general and in detail, with the data on their distribution in the state and in the county as given by Forbes and Richardson in "The Fishes of Illinois," and with Hankinson's data in the "Distribution of Fish in the Streams about Charleston, Illinois."¹²

12. Loc. cit.

Since the streams of Champaign County are so similar and offer the same variety of habitats, it may be assumed that the absence of one of these species from a stream system is due to one of two things: either that it may never have extended its range into that stream, or that it may have been there formerly but is now absent as a result of some catastrophe which wiped it out. Both of these explanations are necessary to account for all the data. The first applies to *Diplesion blennioides*, *Notropis illecebrosus*, and *Schilbeodes miurus*, which are strictly limited to the Wabash drainage in Illinois, and *Etheostoma zonale*, *Notropis gilberti*, and *Pimephales promelas*, which are limited to the Mississippi drainage. The second explanation covers certain changes in the distribution of individual species in the county during the period between the earlier collections of the Survey and the present ones—changes which indicate catastrophes of one kind or another: disease, an exceptionally cold winter or hot summer, pollution, predators, etc.

The most pronounced case of *increase* in abundance is found in the horned dace (*Semotilus atromaculatus*) in the Salt Fork. In the period 1882 to 1901 not a single specimen of this species was taken in the 25 collections of fishes made in this stream and its tributaries, but in 1928 it occurred in 48 out of our 52 collections in the same areas, which thus contributed 1,547 of the total of 2,873 specimens taken this year in the whole county. At the time of the earlier collections small hatchery ponds were maintained in Urbana by the Illinois Fish Commission, and they were stocked with a variety of fishes from various parts of the state. A collection of fishes made in this hatchery by Professor Frank Smith and Mr. R. W. Mills in November, 1898, included among a miscellany of other fishes 3 specimens of the horned dace between 4 and 7 inches long. It seems very likely that individuals escaping or being released from this hatchery into the West Branch served as seed for the stocking of the entire Salt Fork basin, which formerly did not contain this species. The suitability of the Salt Fork as an environment for horned dace is witnessed by their greater abundance in this stream at present than in other parts of the county. It would have been most interesting to follow their spread and multiplication in this system, to see how closely their numbers conformed to the logistic curve of population growth; but without such evidence the length of time involved is entirely problematical.

Another case of remarkable increase is that of the silver-mouthed minnow (*Ericymba buccata*). No minnows of this species were taken in the 8 collections made in May, 1901, in the Sangamon in Champaign County, and only one was taken then in Piatt County; but during last year silver-mouthed minnows have been found in 26 of the 29 collections from that stream, which has thus furnished 1,547 of the 3,519 specimens taken from all the streams of the county.

Evidence indicating the recent appearance of the sheephead in the upper Sangamon has already been presented.

These cases indicate clearly that certain fishes can fare well in places other than their original habitats. With modern transportation facilities and fishes being carted hundreds of miles alive, both for stocking pur-

poses and for bait, it seems certain that within a comparatively short period evidence concerning the original distribution of fishes, as well as racial distinctions, will be obliterated.

There is evidence that the small-mouth black bass is more abundant in the Sangamon now than formerly. None of this species were taken in the 8 collections made in 1901, but 12 of the 29 collections made there in 1928 contained the small-mouth, and these 12 collections furnished 35 of the 44 specimens taken this year in the whole county. It also seems to have increased in the Middle Fork in the same period; for none were taken in the 3 earlier channel collections while 9 were taken in the 4 recent channel collections.

There is some evidence of *decreases* in the abundance of several species. The silvery minnow (*Hybognathus nuchalis*) was taken in 2 out of the 8 former collections in the Sangamon, but not at all in the 29 recent collections in the same stream. The spotted sucker (*Minytrema melanops*) was formerly taken in both the Sangamon and the Middle Fork, but not at all in 1928. It is possible that the increase in small-mouth black bass in these two streams may have had something to do with the disappearance of the above fishes.

A number of species formerly present in the stretch of the Salt Fork between Urbana and the Homer Dam are now absent, obviously because they are not tolerant to pollution.

A few other species in other streams of the county may have changed their range or abundance, or both, since 1901, but the earlier collections were not extensive enough to justify statistical comparisons except in the Salt Fork and the Sangamon.

The above observations on changes in distribution do not substantiate the view that the fish life of a stream is a highly integrated whole to which nothing can be added or subtracted without upsetting the "balance."

ASSOCIATION OF SPECIES

Most instances of the association of different species of fishes are explained satisfactorily by similar environmental preferences. This phase of the ecology of Illinois fishes has been treated very completely and critically by Professor Forbes in "Fresh-water Fishes and Their Ecology," and "On the Local Distribution of Certain Illinois Fishes: an Essay in Statistical Ecology." In these papers he has presented coefficients of association of certain species with certain other species and with certain environmental characteristics. Tables of such coefficients for important food and game fishes and their associates can be put to good use in formulating principles for the efficient management of our waters and in making recommendations for planting important fishes in waters where they are not already present. In actual practice a body of water in which planting is to be done would be inspected as to its general features and the more abundant kinds of fishes noted. Desirable kinds of fishes not already present would be selected for successful planting from those showing high coefficients of association, elsewhere.

with fishes already present and with the general features of the aquatic environment.

An instance of another order of association of species came to light in the course of the present study, a new order of association that is distinguished by its extreme exactness. It approaches the order of correlation to be expected between males and females of the same species and implies that at some stage in their life history the presence of both species is necessary for the maintenance of a large population of either.

This new kind of association was discovered in the relations of two large minnows: the horny head, *Hybopsis kentuckiensis*; and the shiner, *Notropis cornutus*. One or both of these minnows were taken in 55 of the 132 collections in the county, and all but two of these 55 collections were made in three river systems—the Sangamon, Kaskaskia, and Middle Fork—the two exceptions being in the Salt Fork basin. *Notropis cornutus* occurred in 54 of these 55 collections and *Hybopsis kentuckiensis* in 46 of them. To put it on the basis of number of individuals: 2,618 specimens of *Notropis cornutus* were taken in all, of which 2,590 were in the same collections with *Hybopsis kentuckiensis*; and of the 1,221 specimens of *Hybopsis kentuckiensis*, 1,217 were taken in collections with *Notropis cornutus*. The actual number of each of these species in each of the 55 collections in which one or both were taken during 1928 is shown in Table XII.

An inspection of the distribution maps of these two species indicates that they both are restricted to certain systems very much as the seventeen other species which have been described earlier in this paper as showing isolation. There are, however, several important points in which these two fishes do not conform with the characteristics of other species with a restricted distribution. All our other restricted fishes are small (not exceeding $3\frac{1}{4}$ inches in length in this area) and either sedentary in habit or restricted to certain limited types of environment, but these two are our largest minnows, specimens of both having been taken more than 6 inches in length. Furthermore, they are both strong swimmers and are not sedentary in any sense of the word. Neither are they restricted to any limited type of environment, both of them having been found in almost every type of stream environment in this area.

It is often mentioned in the literature that *Notropis cornutus* is a typical small-stream fish while *Hybopsis kentuckiensis* is more characteristically found in large rivers. This difference is not indicated by our Champaign County data. Following is a tabulation of the average numbers of these two species per 100 square yards of water area in streams whose sizes are expressed in square miles of drainage area:

	1	2	4	8	16	32	64	128	256	512
<i>Notropis cornutus</i>	10.0	25.0	88.8	64.3	132.6	141.0	31.7	35.8	10.8	
<i>Hybopsis kentuckiensis</i>	0	4.5	2.0	46.9	74.1	33.6	11.3	17.6	9.2	

The largest specimen of the shiner was taken in the same collection as the largest chub. There is, moreover, a general correspondence between the sizes of these two fishes in all our collections in the county.

The association of these two species is not obviously a predator-victim relationship, because studies of their stomach contents show them both to be omnivores, taking either plant or animal foods of a wide variety. For many years I have taken these two fishes in almost equal numbers on trout flies and a variety of other baits on the riffles of Wild Cat Creek near Lafayette, Indiana.

The degree of association of these two species in the state at large does not appear so exact as in Champaign County. One or both of them occurred in 203 of the 1,800 collections of fishes reported by Forbes and Richardson. *Notropis cornutus* occurred in 185, and *Hybopsis kentuckiensis* in 139, of those 203 collections. On the basis of numbers of individuals: 725 of the 855 specimens of *Hybopsis kentuckiensis* taken in the state were taken in the presence of *Notropis cornutus*;

Table XII. Numbers of *Hybopsis kentuckiensis* and *Notropis cornutus* and total of all fishes in Champaign County collections in which one or both of these species occur. Arranged in order of decreasing stream size within each stream system.

Hybopsis kentuckiensis	Notropis cornutus	Total of all fishes in collection	Hybopsis kentuckiensis	Notropis cornutus	Total of all fishes in collection
Sangamon River			Kaskaskia River		
6	9	434	4	51	223
19	8	289	—	2	37
20	28	324	6	100	177
24	39	332	39	27	128
17	11	144	44	37	107
14	22	240	21	66	121
3	4	236	64	21	134
15	11	302	111	11	278
36	68	399	8	2	115
23	44	408	89	33	263
33	88	374	42	33	130
40	193	532	10	76	110
6	18	83	4	—	14
21	59	940	4	38	89
31	150	714			
27	212	506	Middle Fork River		
28	161	442	13	43	615
25	134	320	6	31	321
51	135	376	11	35	152
55	137	503	7	35	420
10	50	321	—	2	137
123	41	261	3	110	368
3	32	41	—	4	182
68	41	321	—	3	546
2	37	152	—	2	174
3	13	35	Salt Fork River		
31	73	649	—	1	37
—	14	160	—	2	324
—	1	43			
1	11	19			

conversely, 2,184 of the 2,666 specimens of *Notropis cornutus* were taken with *Hybopsis kentuckiensis*. The lower incidence of these two species and the comparative smallness of the earlier collections would tend to lower the probability that specimens of both would be included in any given collection. However, the state-wide data does contain some evidence that one of these species, particularly *Notropis cornutus*, can occur in larger streams independent of the other.

The general distribution of *Notropis cornutus* is given by Jordan and Evermann¹³ as,—“Entire region east of the Rocky Mountains excepting the South Atlantic States and Texas; *almost* everywhere the most abundant fish in small streams. Its variations are great, some of them appearing like distinct species.” The general distribution of *Hybopsis kentuckiensis* is given as,—“Pennsylvania to Wyoming and Alabama, on both sides of the Alleghenies; everywhere abundant in the larger streams, seldom ascending small brooks; western specimens usually have the teeth in two rows. Variable.”

Reports on the fishes of many other areas within the range of these species clearly indicate a correspondence of the detailed distribution of the chub with the shiner.

The explanation of why these two species show isolation in certain stream systems seems to be embodied in the nature of their association. It may be that, while they are necessary to each other's existence at least to attain abundance, the necessity of their association extends over only a part of their life history, so that they can move into other areas independently of each other. Whether or not they shall occupy the new area, may then depend on the small probability that they should both get there at the same time.

SUMMARY

Champaign County, which is nearly level upland plain, embraces the neighboring headwaters of six stream systems which diverge in various directions, sending their waters into the tributaries of the Wabash on the east and the Mississippi on the west.

Quantitative collections containing 28,905 fishes were made in 1928 from 132 localities on these streams, and with these were combined for study the product of 40 collections from this same area, made in the course of a general survey of the fishes of the State in the period 1882-1901. The identity of the specimens from all these collections has been determined, and the data of their distribution and abundance in the different seasons and in the several habitats of each stream have been organized to show factors affecting distribution. These two series of collections, together with a few miscellaneous collections and reports from Champaign County, include representatives of 74 species.

13. Jordan, David Starr, and Evermann, Barton Warren: “The Fishes of North and Middle America.” Bulletin 47, Smithsonian Institution, U. S. National Museum. 1896.

From the data of 1928 it appeared that the streams of the county contained an average of three fishes per square yard of water, equivalent to 15,000 fishes per acre, with a total weight per acre of about 150 pounds.

Data of temperatures and rainfall are given for 1928, when the collections were made, and for the 26 years during which accurate observations have been recorded.

Dredging of the streams for farm drainage is common, and its effect on the fishes are temporarily serious; but erosion and the growth of water plants and of stream-side shrubs and trees presently reproduce original conditions, so that the general effect of dredging is not important.

The coarse aquatic plants of the waters of the county are listed with statements as to the situations in which they occur.

Nine principal classes of habitats in Champaign County streams are recognized, and the species of fishes most characteristic of each are listed.

The number of fishes per unit area varies from seven per square yard in extreme headwaters down to two per square yard in the larger streams, but this decrease in number of fishes downstream is more than counterbalanced by an increase in the average size of the individual fishes.

In comparing the range of stream sizes which different species inhabit, it was found most satisfactory to throw the data on drainage areas into size classes which increase as a geometrical progression, each class being made twice the preceding class; for the numbers of fishes per unit area and the numbers of species per collection, when plotted against stream sizes on this scale, give curves that approximate straight lines—a good empirical reason for assuming that this is a correct method of comparison.

Some species which reach their greatest abundance at certain points in a stream also reach their greatest abundance in other streams at points with the same drainage area, without reference to distance from source or mouth.

Some species are sharply limited to a certain stream size, while others are more generally distributed but fluctuate about a certain stream size as a mode.

Although the young and adults of most species reach their greatest abundance in streams of the same size, the young of certain species of suckers regularly occur in smaller streams than do adults of the same species.

Fishes of the extreme headwaters are the hardest, most tolerant of pollution, and most nearly omnivorous.

Correlation between unusual fertility of soil and abundance, rate of growth, and adult size of fishes is illustrated by an extraordinarily productive tract drained by Spoon River which yielded twice as many fishes to a given area and four to five times as many pounds of fish as the average for the county.

The effects of pollution are illustrated by an extreme scarcity of fishes—as for example, downstream from Champaign and Urbana, notwithstanding the operation there of a modern sewage disposal plant above which there were thirty times as many fishes per unit area and four times as many kinds as below. (See footnote 10, page 54.)

There are distinguished three types of morphological adaptation of fishes to the size of streams and velocity of their flow.

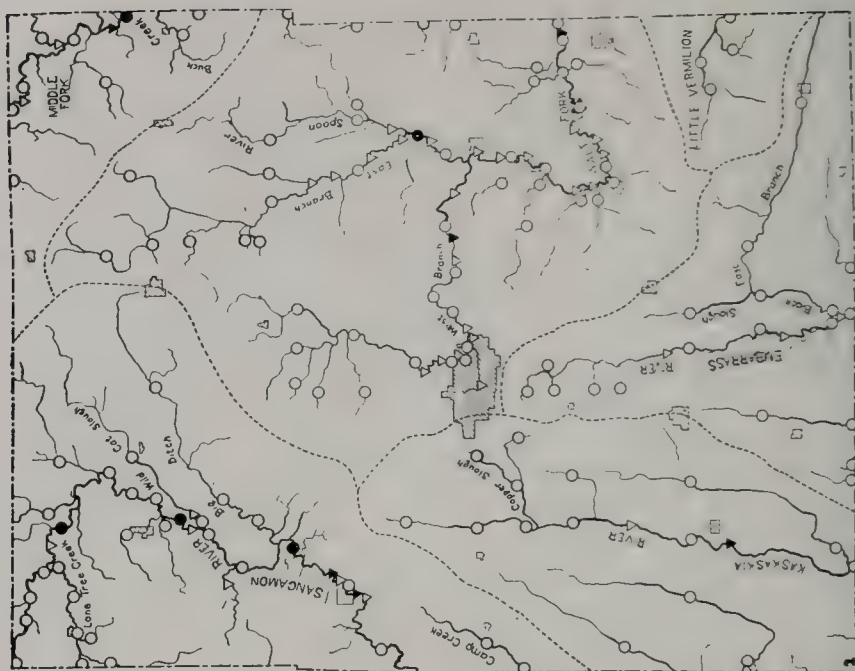
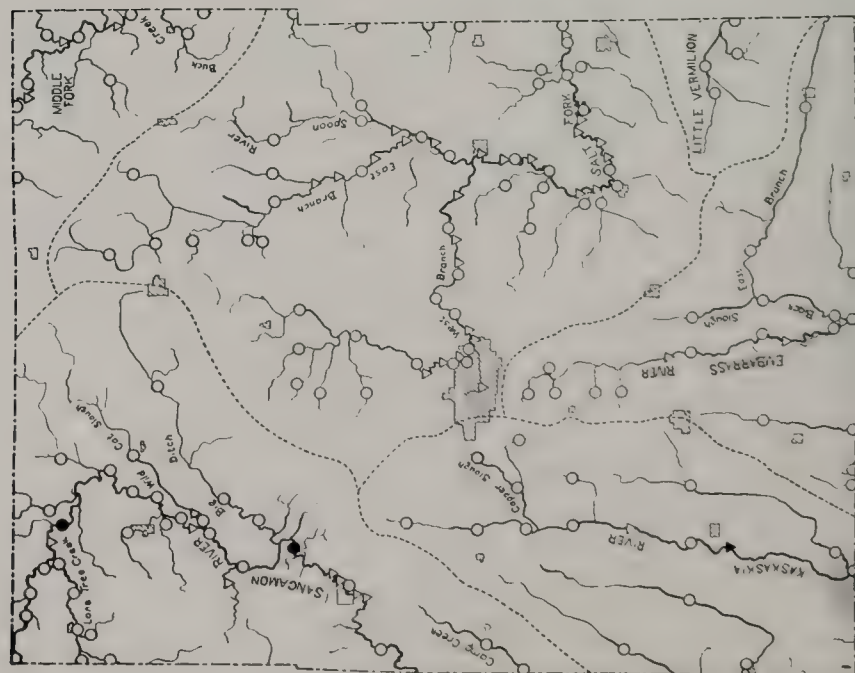
Notwithstanding the close neighborhood of the headwaters of the different stream systems and the similarity of their habitats and of their drainage basins, the local distribution of their species is so restricted that 17 species are wanting in from one to five of the six stream systems of the county; but examples are given of the ability of species thus isolated to survive and multiply in other waters if they gain access to them.

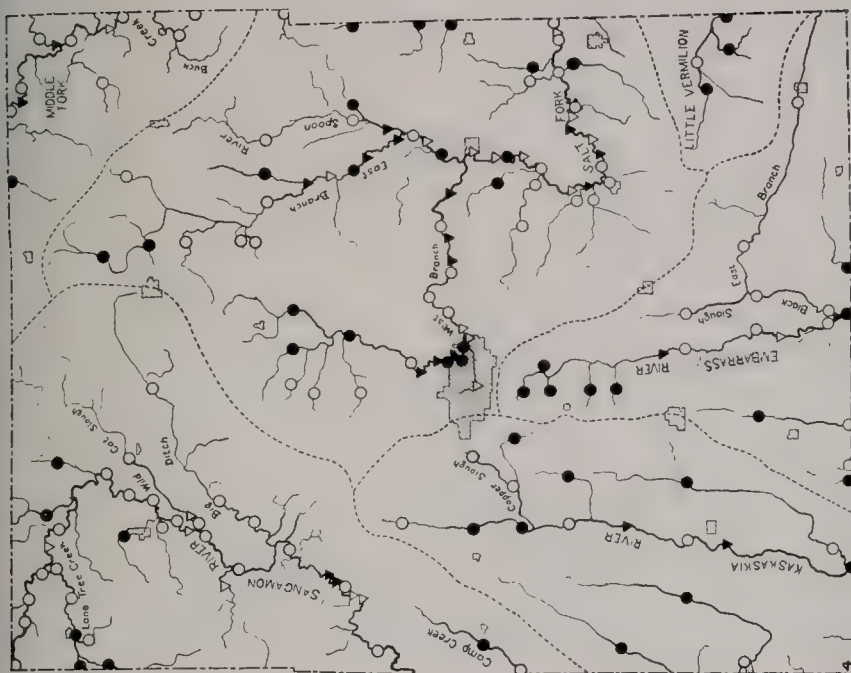
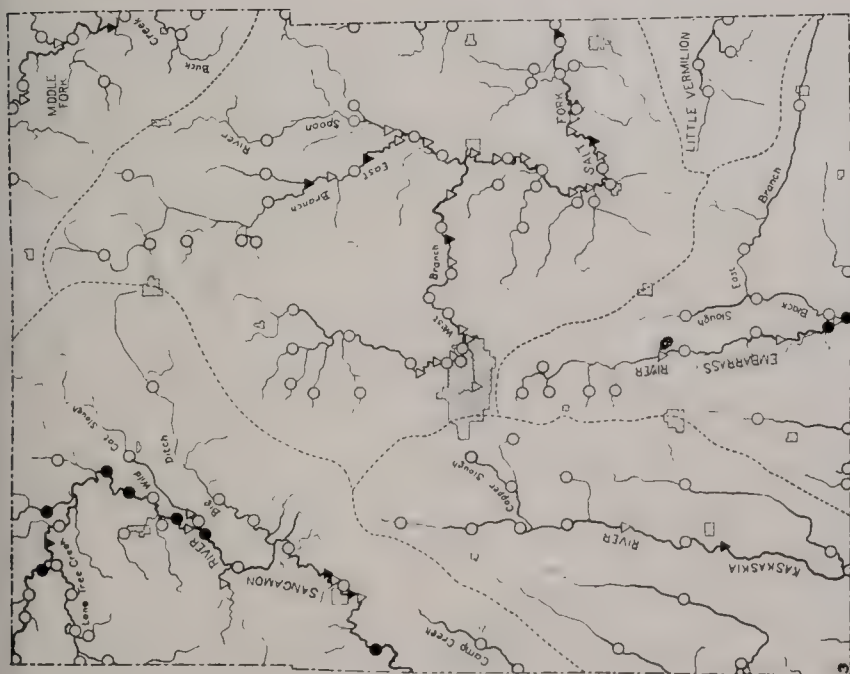
Attention is called to the indispensable importance of a knowledge of the natural limitations of the distribution and survival of economic species in different habitats, without which wasteful efforts will be made to introduce desirable species where they cannot thrive.

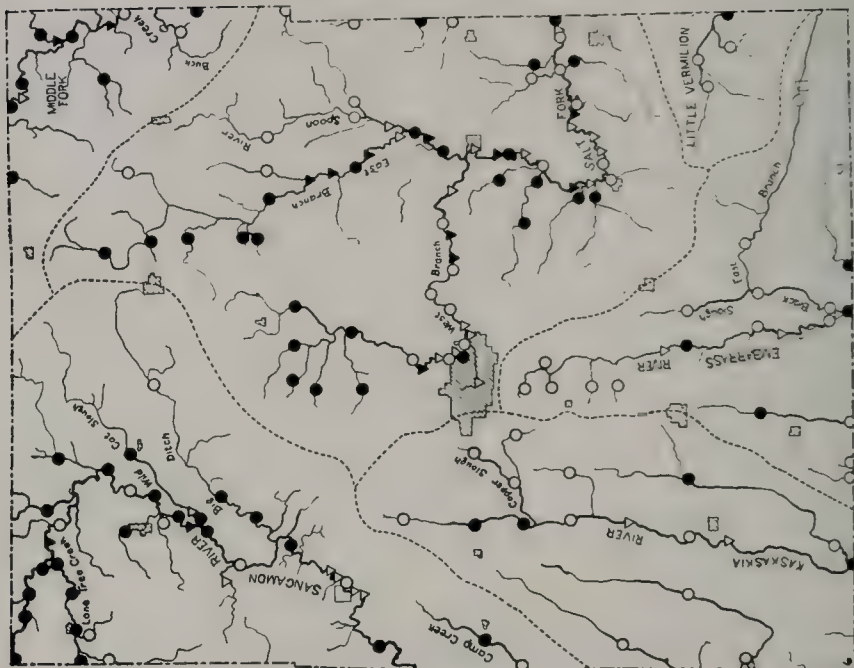
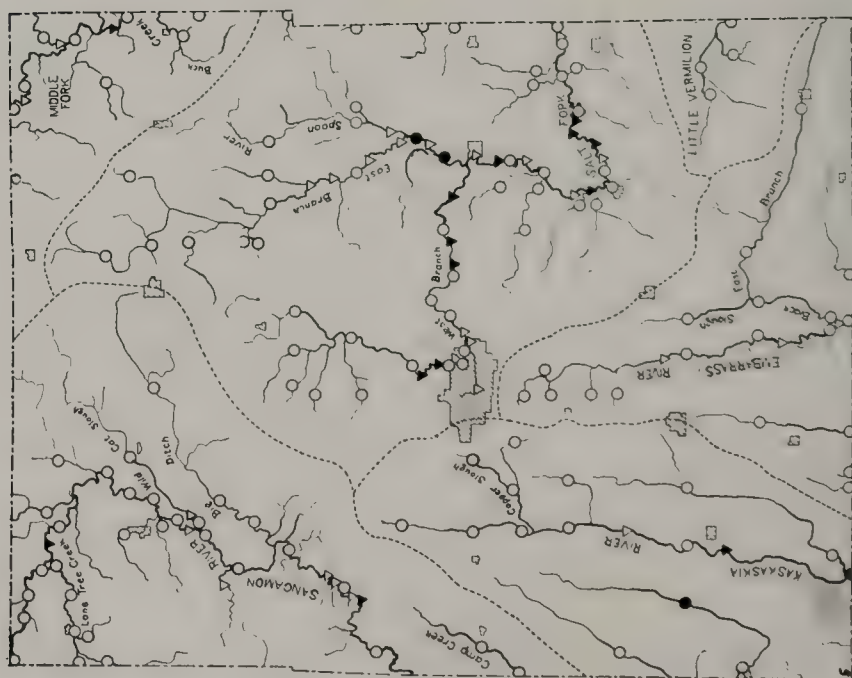
Two species, *Hybopsis kentuckiensis* and *Notropis cornutus*, exhibited an extraordinary and unexplained association, being found together in 99 per cent of the collections in which either one of them occurred.

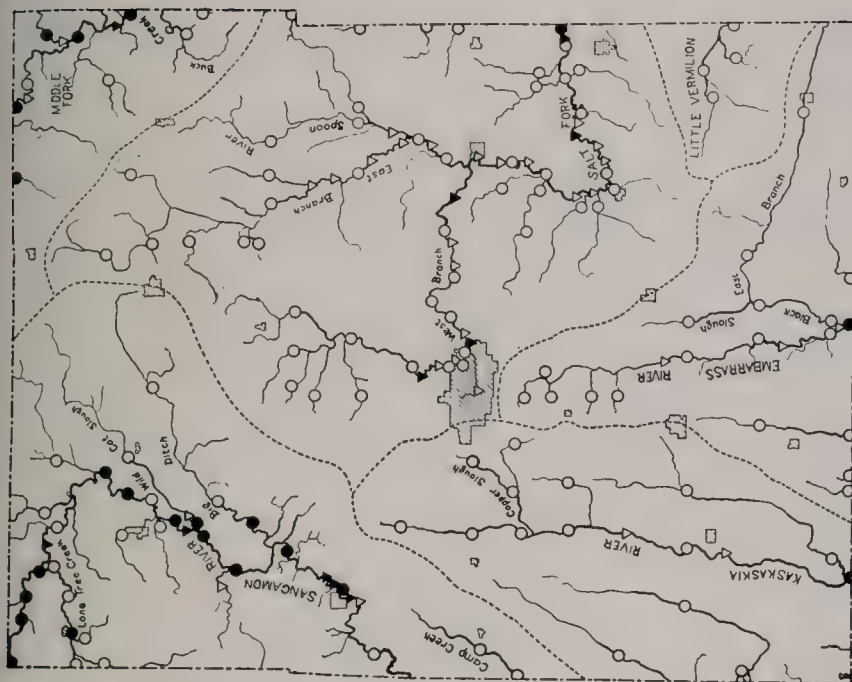
DISTRIBUTION MAPS

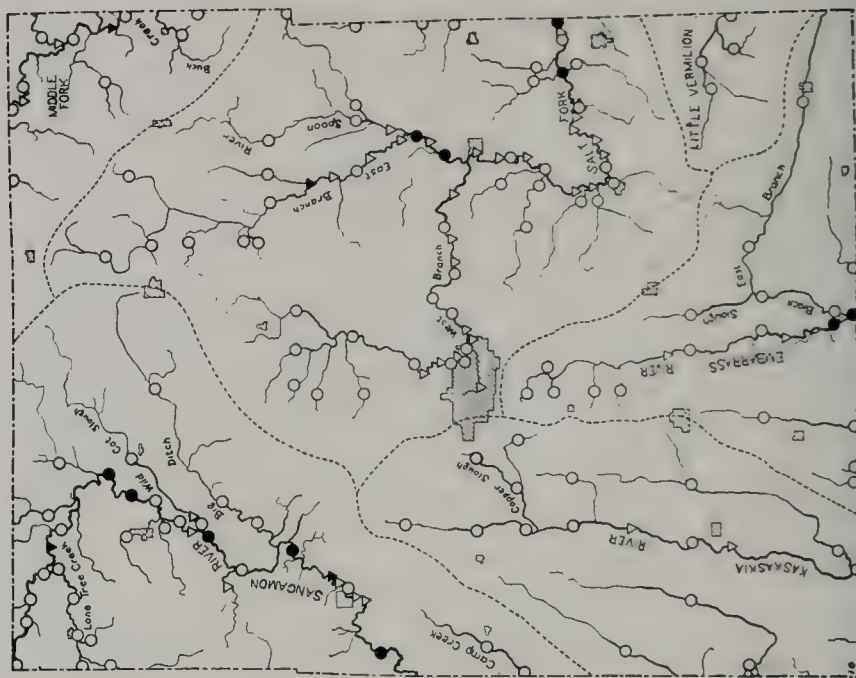
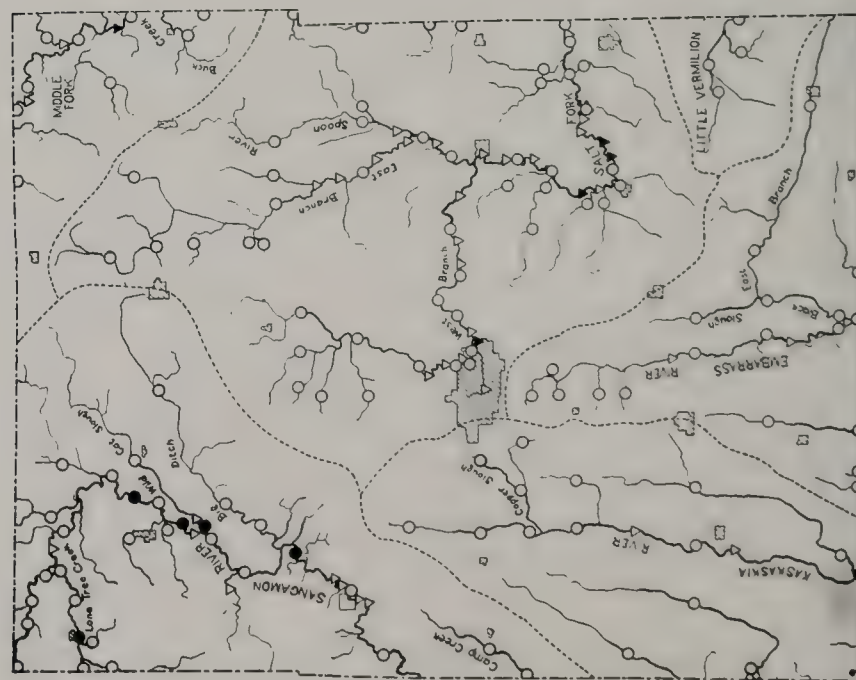
On the following pages distribution maps are shown for all species which were represented by ten or more specimens in the collections of 1928. Circles indicate places where collections were made in 1928, and triangles where collections were made in the period 1882-1901. The occurrence of each species is indicated by the use of these symbols in solid black. (For index, see p. 99.)

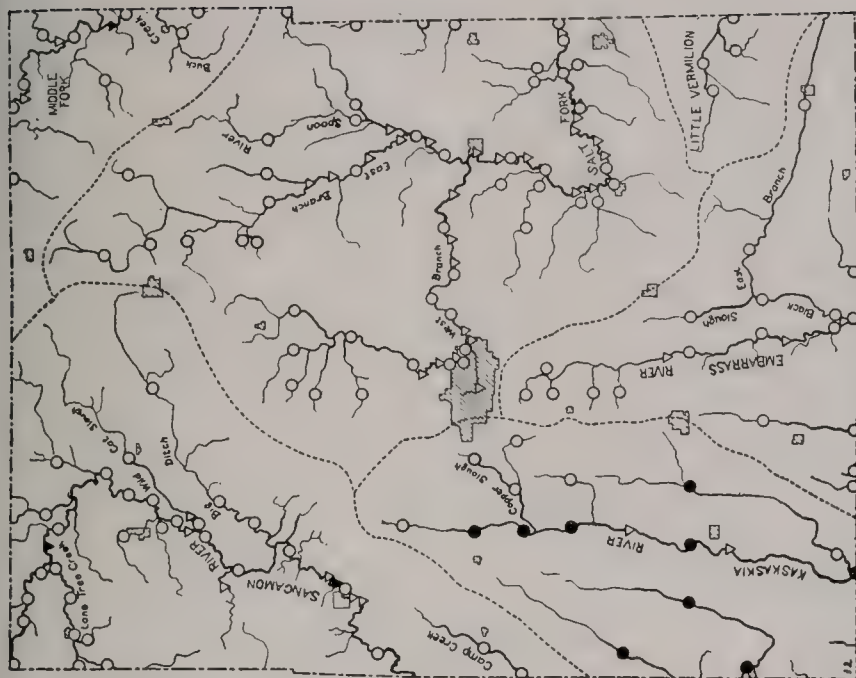
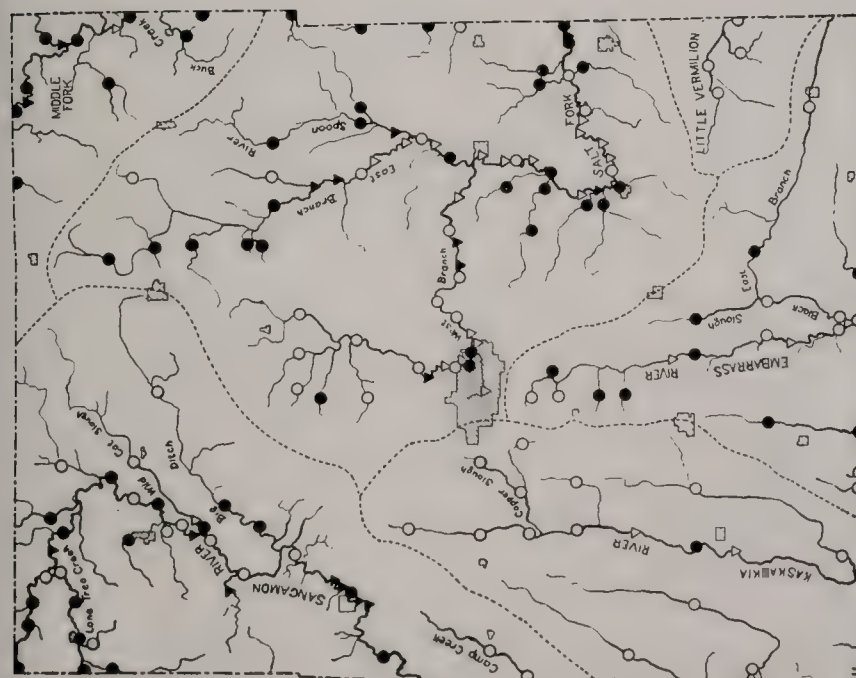
Map 2. Distribution of *Carpiodes difformis*—Blunt-nosed river carp.Map 1. Distribution of *Dorosoma cepedianum*—Gizzard-shad.

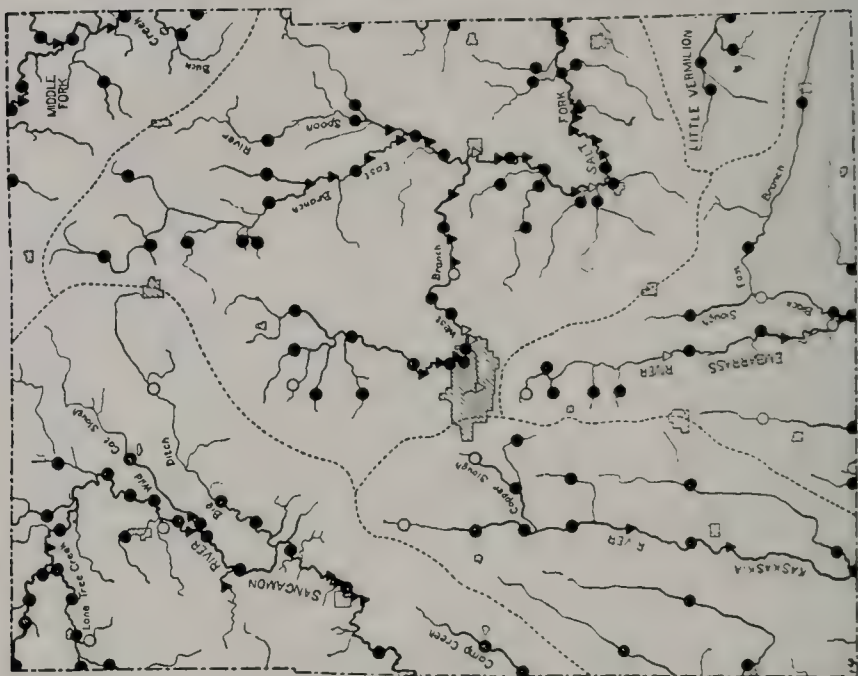
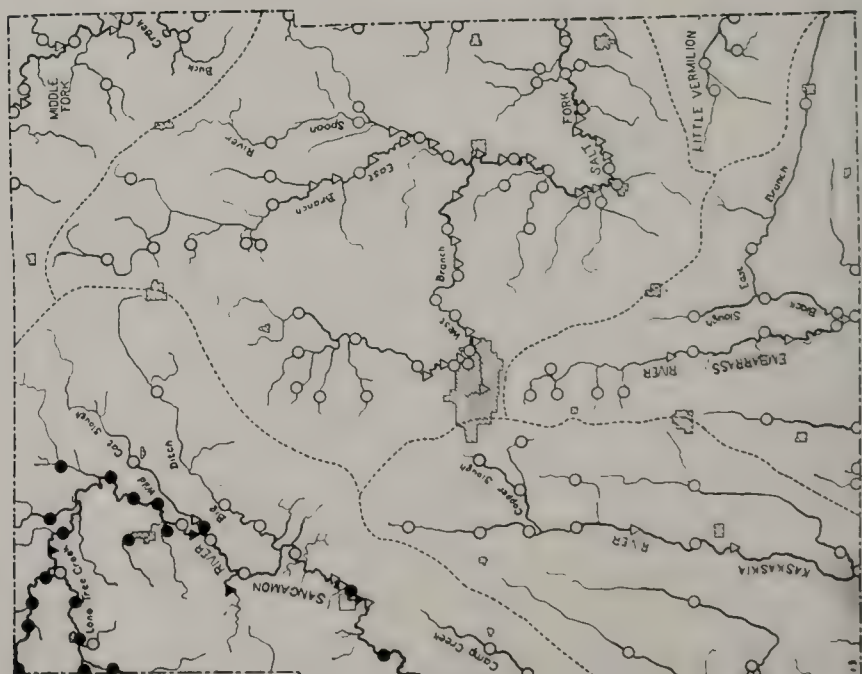
Map 4. Distribution of *Erimyzon succetta oblongus*—Chub-sucker.Map 3. Distribution of *Carpiodes velifer*—Quillback.

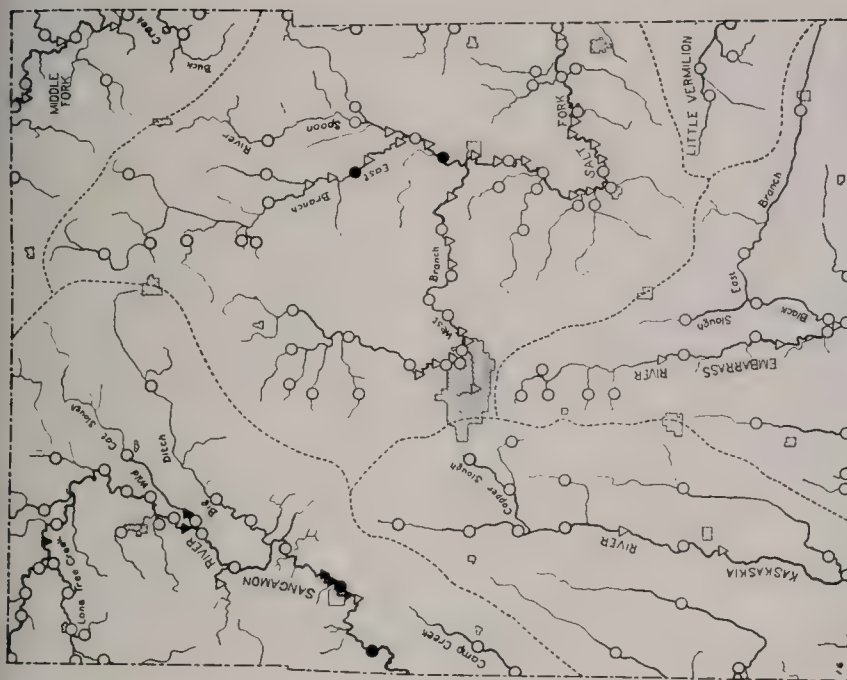
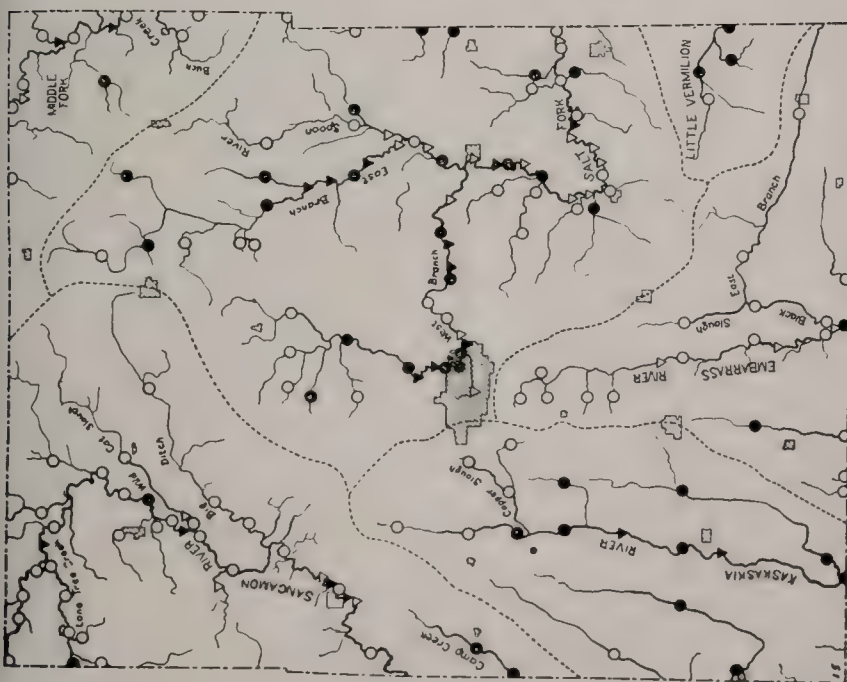
Map 6. Distribution of *Catostomus commersonii*—Common sucker.Map 5. Distribution of *Minytrema melanops*—Spotted sucker.

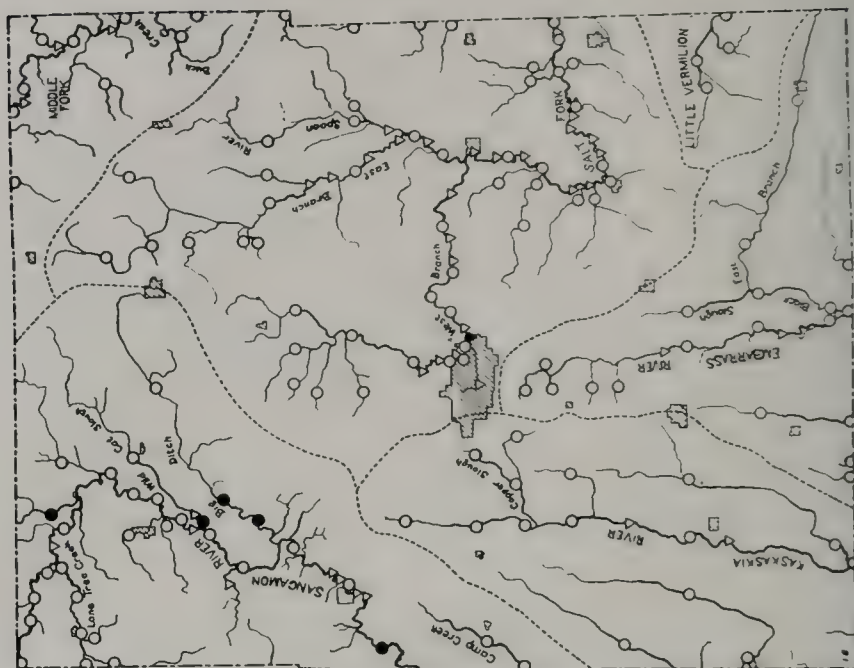
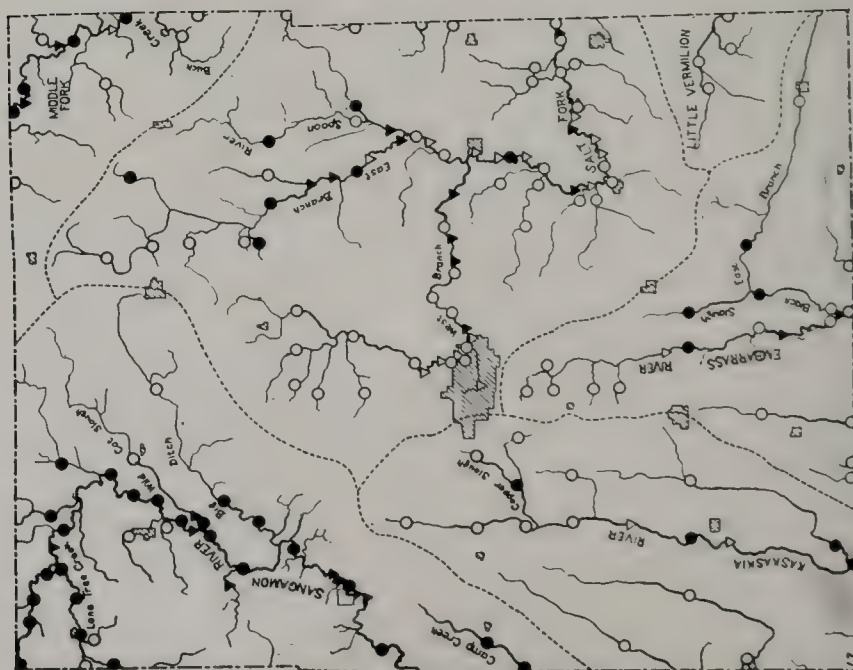
Map 8. Distribution of *Morostoma aureolum*—Common red-horse.Map 7. Distribution of *Catostomus nigricans*—Hogsucker.

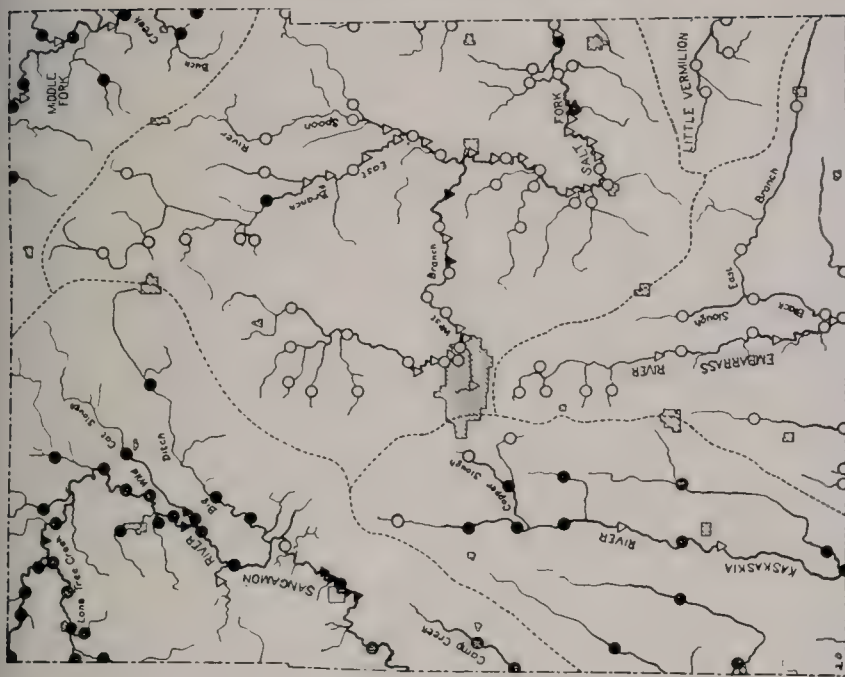
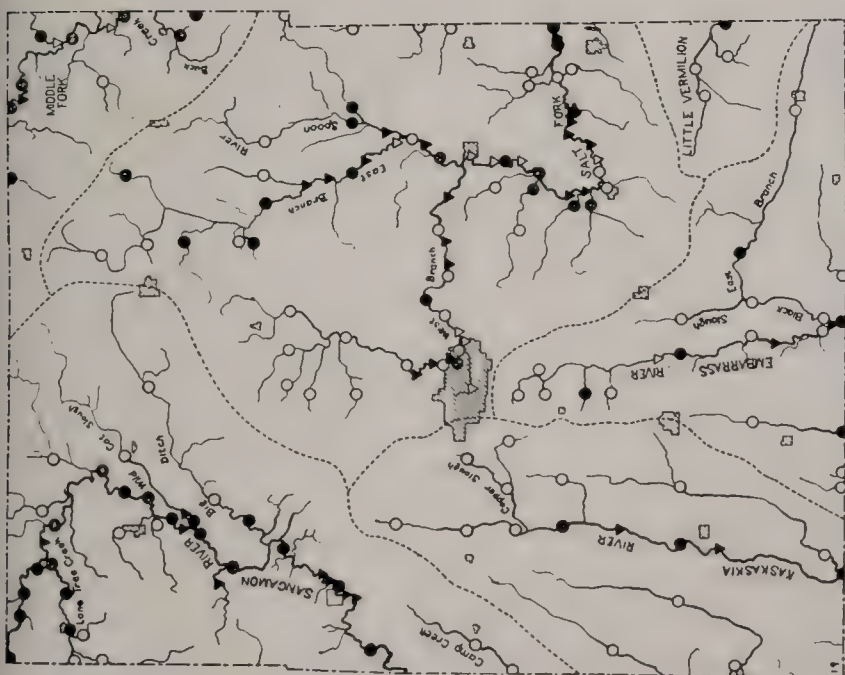
Map 10. Distribution of *Cyprinus carpio*—Carp.Map 9. Distribution of *Moxostoma breviceps*—Short-headed redhorse.

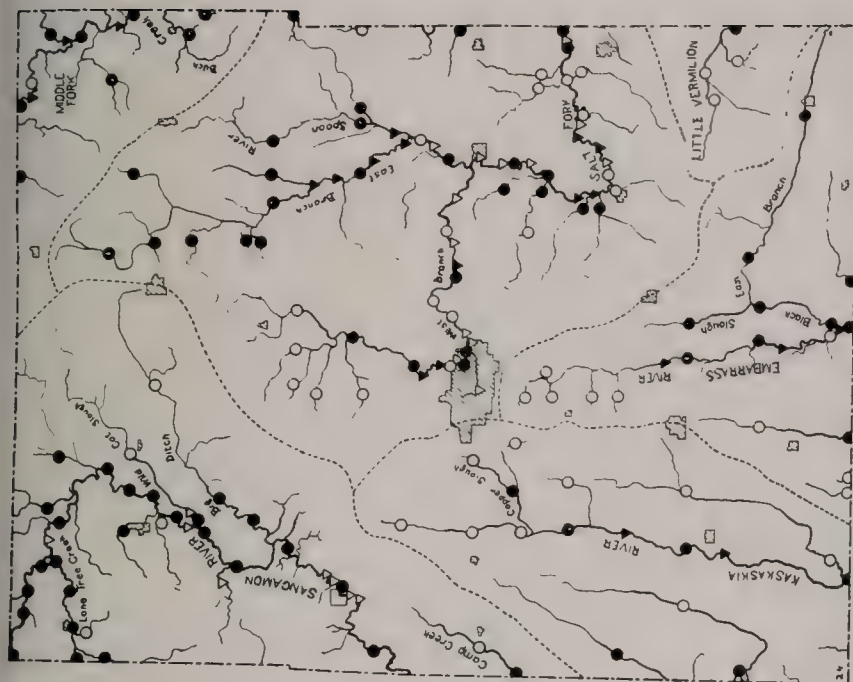
Map 12. Distribution of *Hybognathus nuchalis*—Silvery minnow.Map 11. Distribution of *Campestris anomala*—Dough-belly.

Map 14. Distribution of *Pinephiles notatus*—Blunt-nosed minnow.Map 13. Distribution of *Pinephiles promelas*—Fathead minnow.

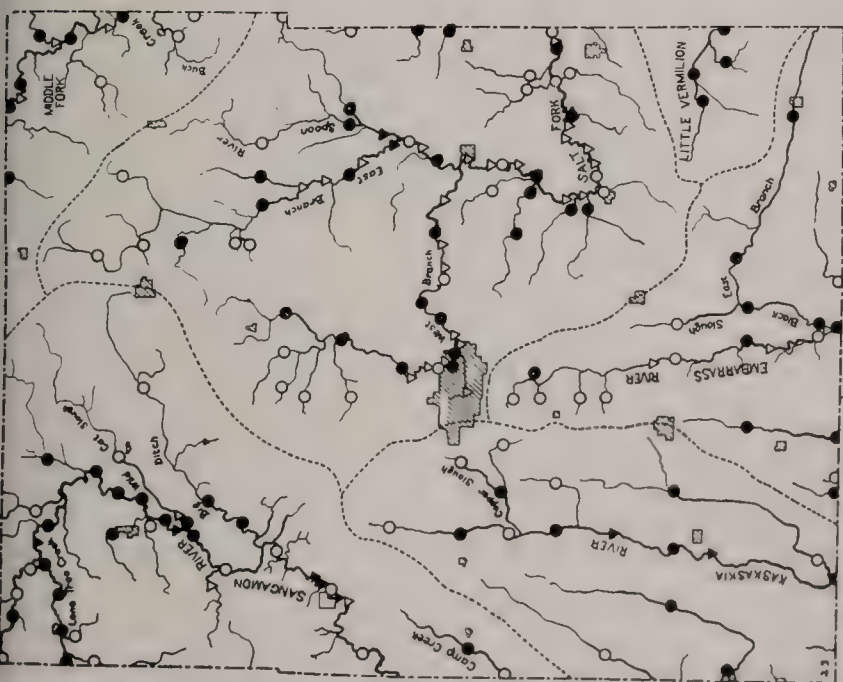
Map 16. Distribution of *Chloa rigilar*—Bullhead minnow.Map 15. Distribution of *Abramis crysoleucas*—Golden shiner.

Map 18. Distribution of *Notropis gilberti*—Gilbert's minnow.Map 17. Distribution of *Notropis bleekeri*—Straw-colored minnow.

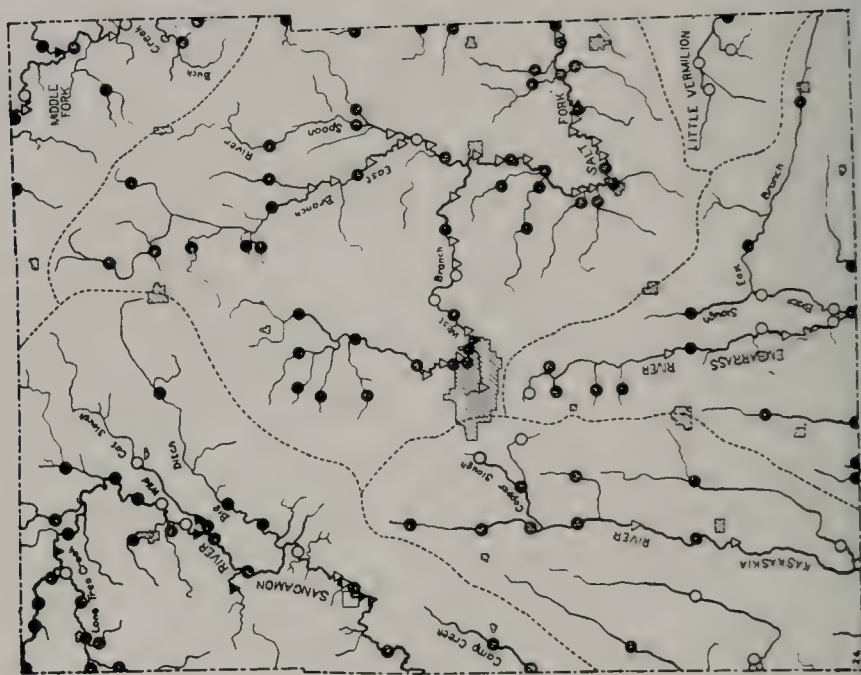
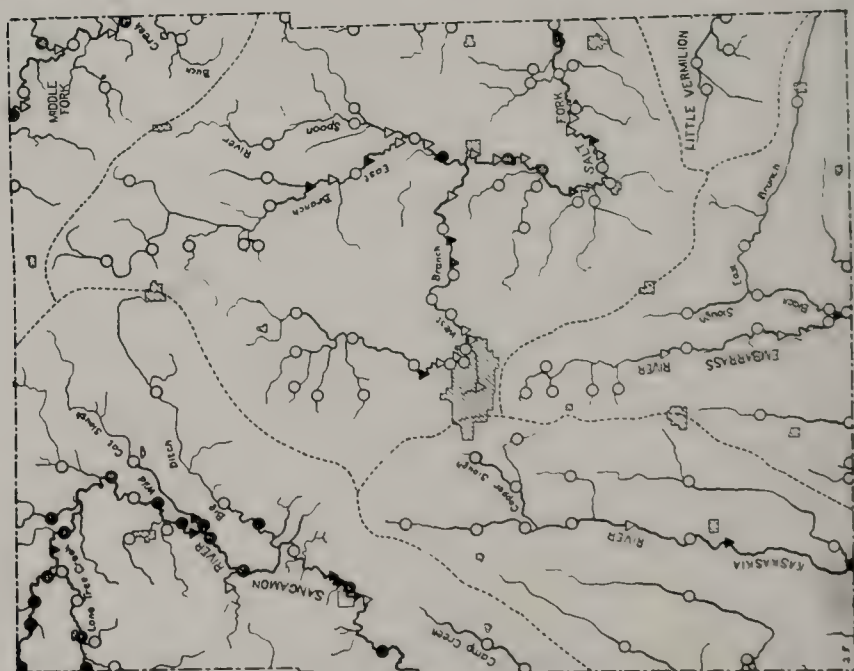
Map 20. Distribution of *Notropis cornutus*—Common shiner.Map 19. Distribution of *Notropis whifflii*—Steel-colored minnow.

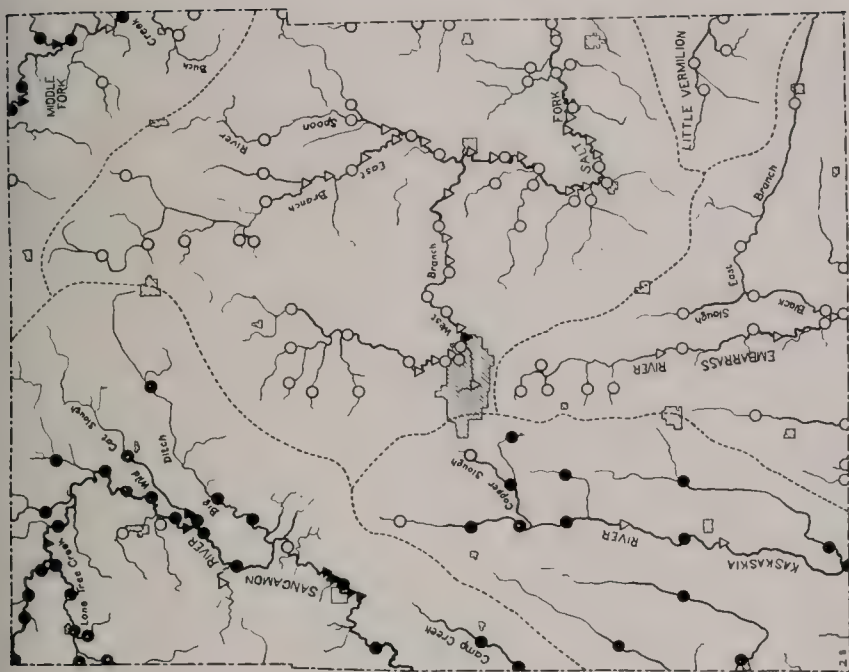
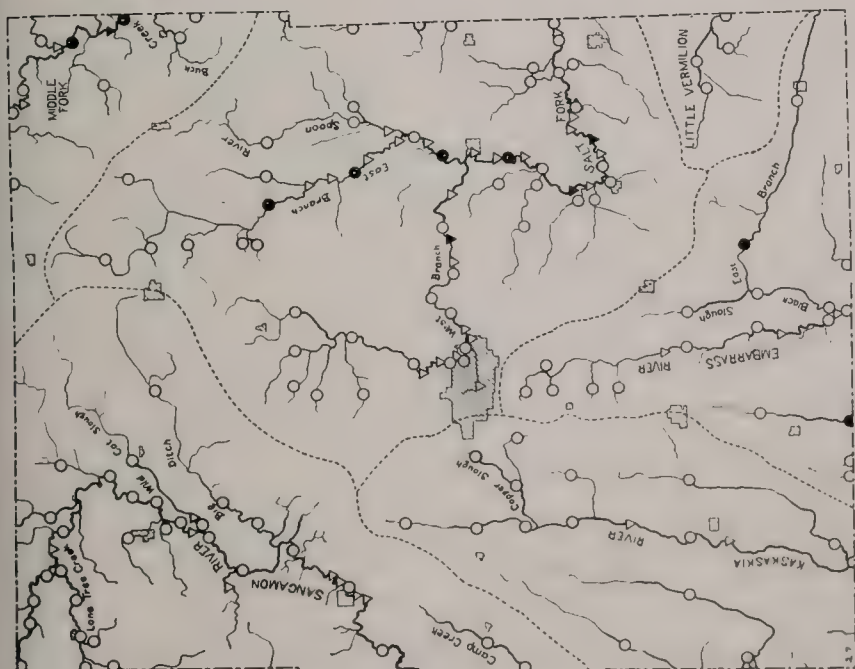


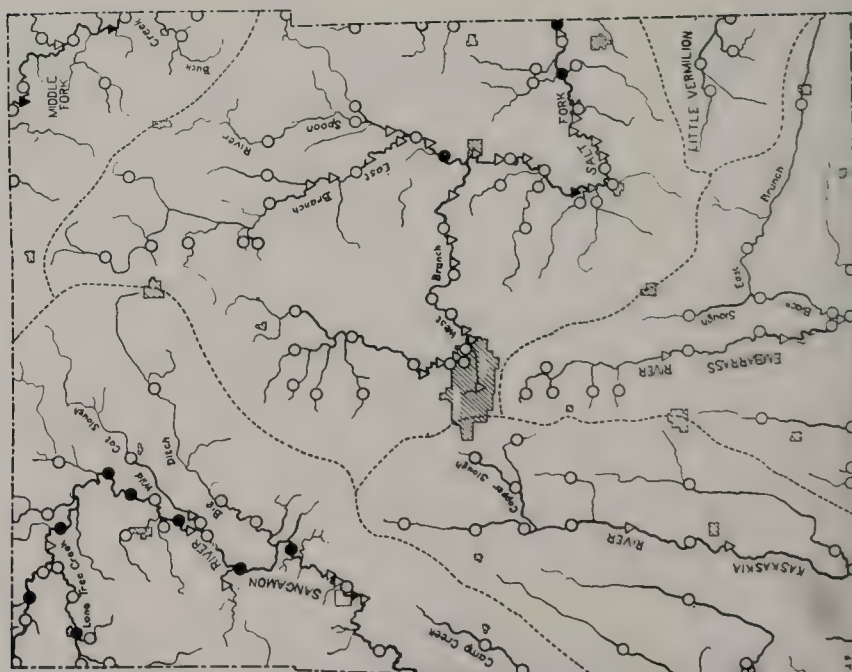
Map 24. Distribution of *Ercymba buccata*—Silver-mouthed minnow.

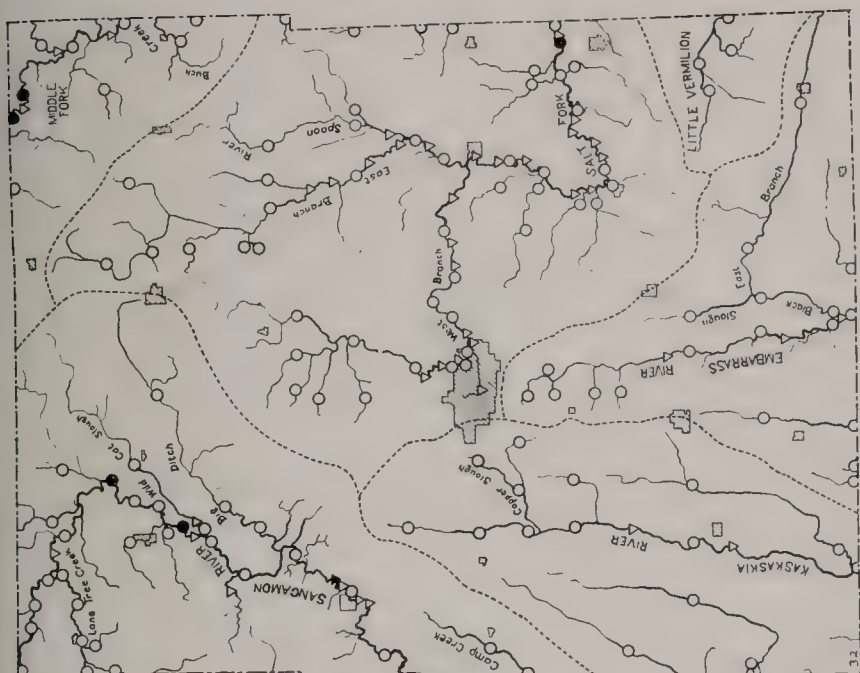
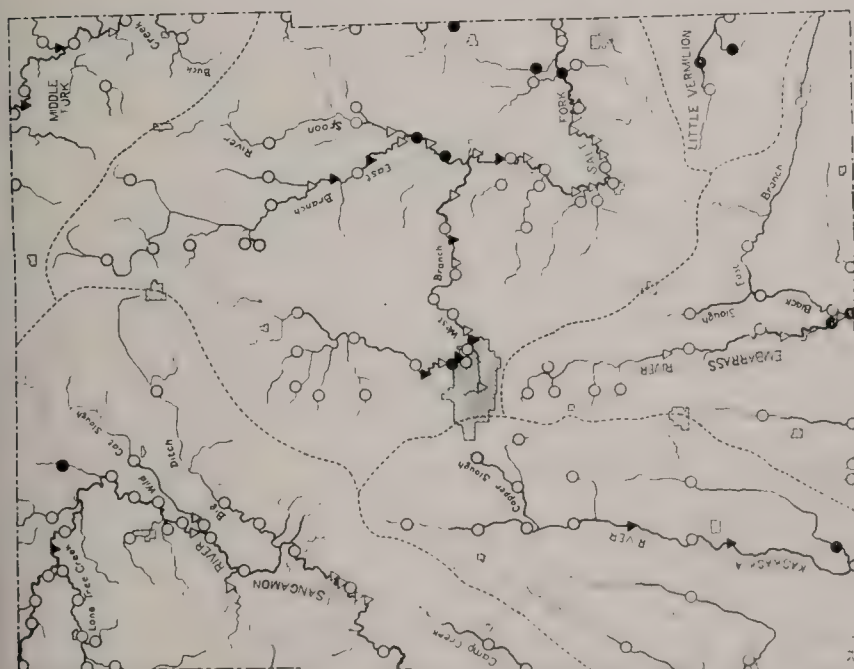


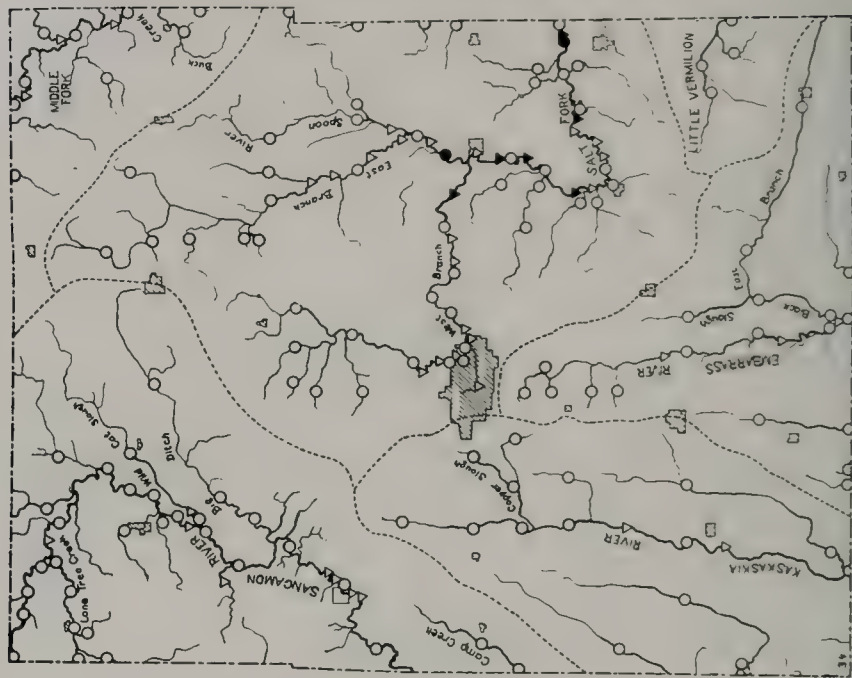
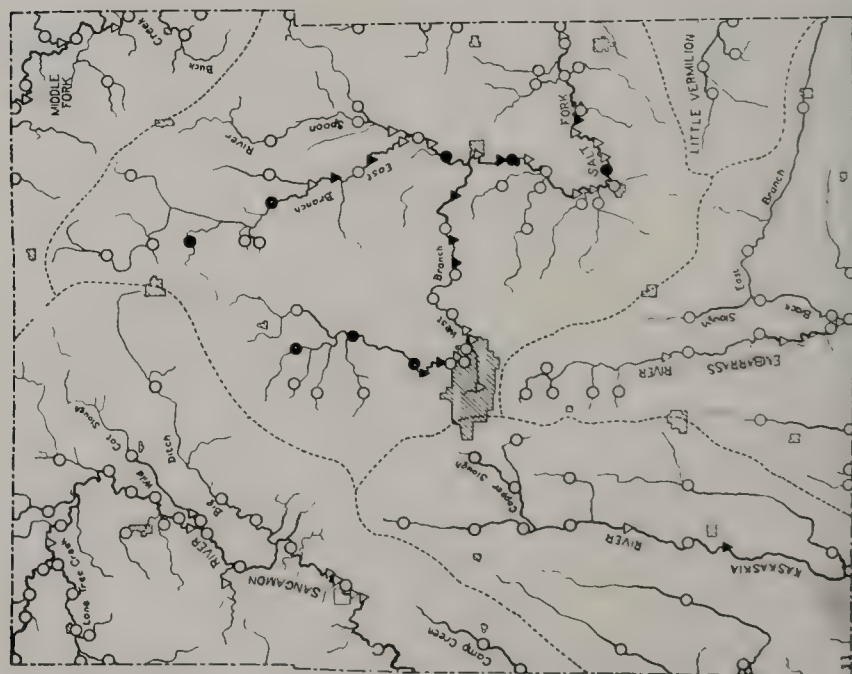
Map 23. Distribution of *Notropis umbratilis atropis*—Blackfin minnow.

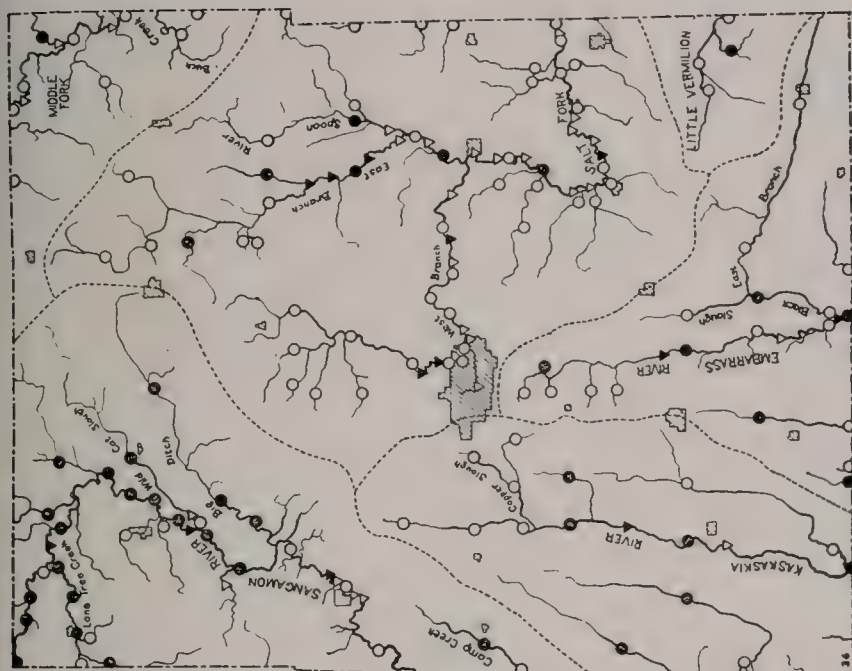
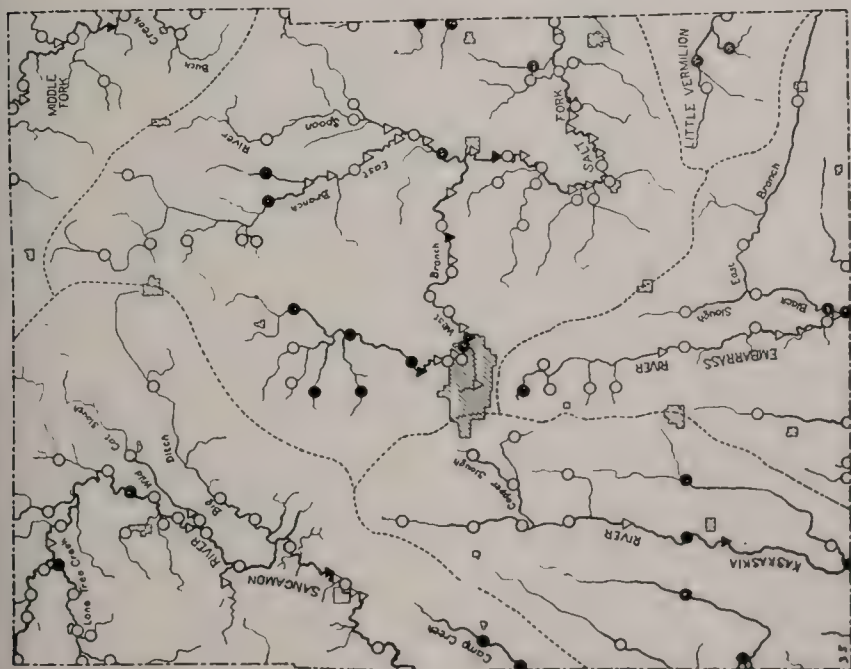
Map 26. Distribution of *Semotilus atromaculatus*—Horned dace.Map 25. Distribution of *Phacelobius mirabilis*—Sucker-mouthed minnow.

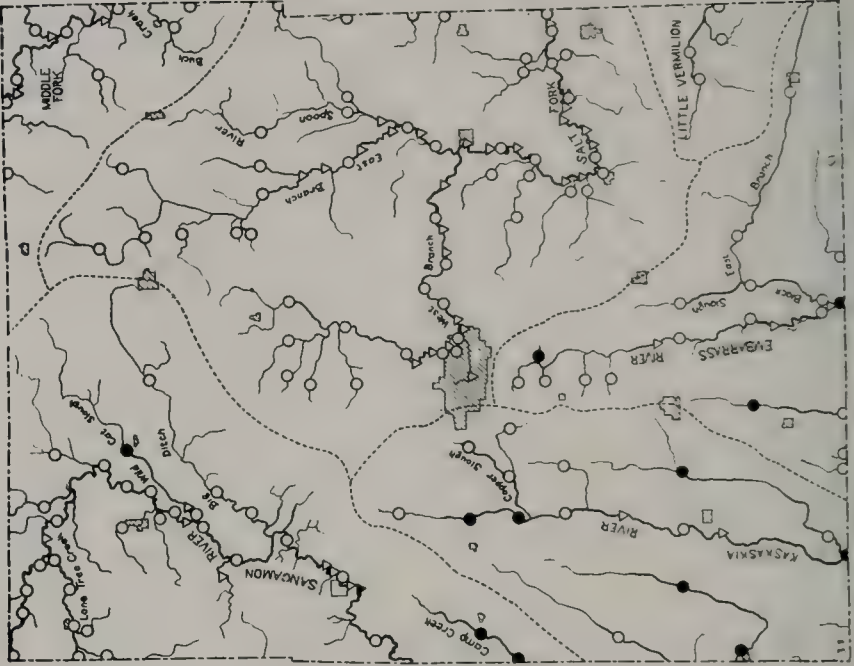
Map 28. Distribution of *Hybopsis kentuckiensis*—Horny-head.Map 27. Distribution of *Hybopsis amblopes*—Big-eyed chub.

Map 30. Distribution of *Ameletus natus*—Yellow bullhead.Map 29. Distribution of *Ictalurus punctatus*—Channel-cat.

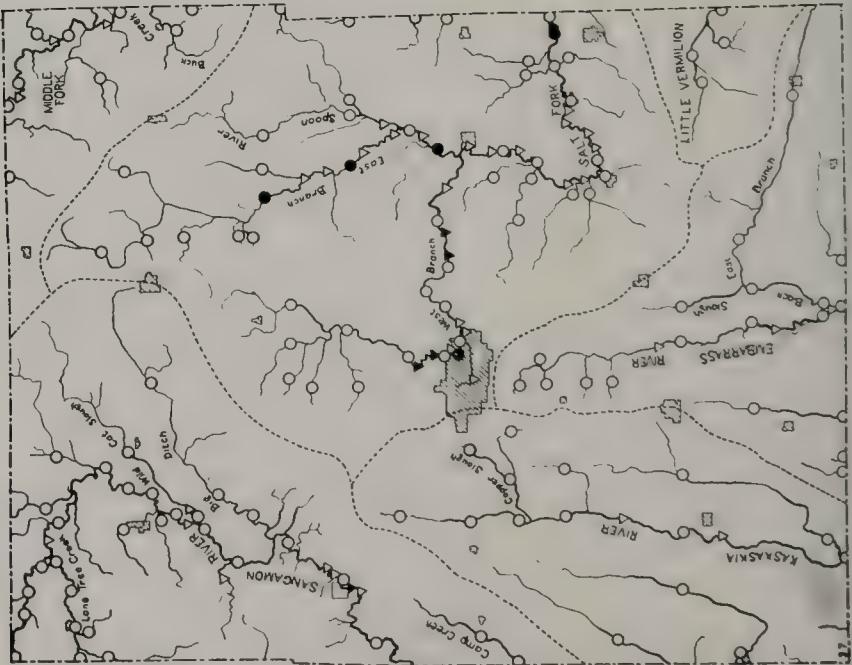
Map 32. Distribution of *Noturus flavus*—Stoner cat.Map 31. Distribution of *Ameiurus melas*—Black bullhead.

Map 33. Distribution of *Schilbeodes gymnus*—Tadpole cat.Map 34. Distribution of *Schilbeodes mirus*—Brimled stonecat.

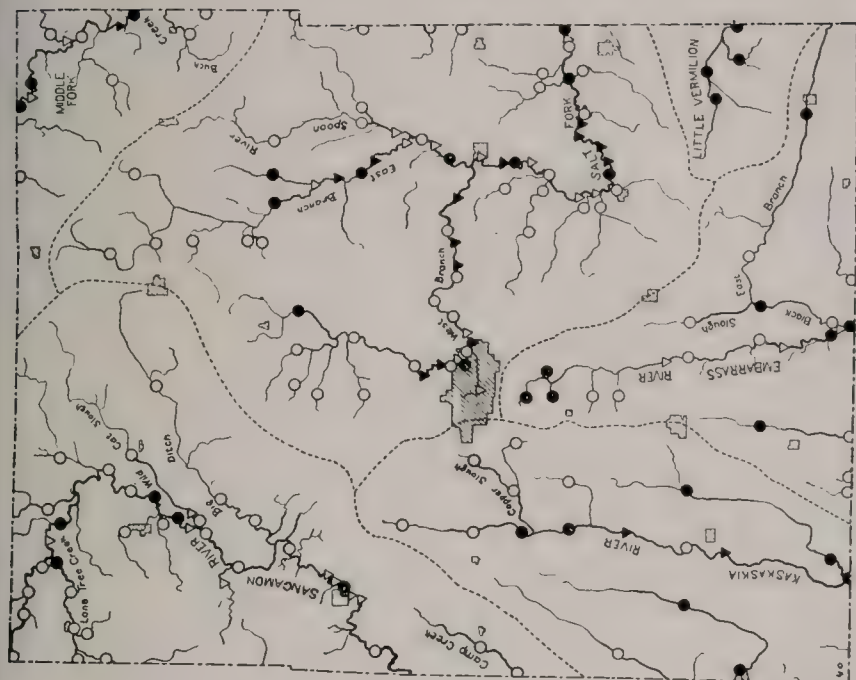
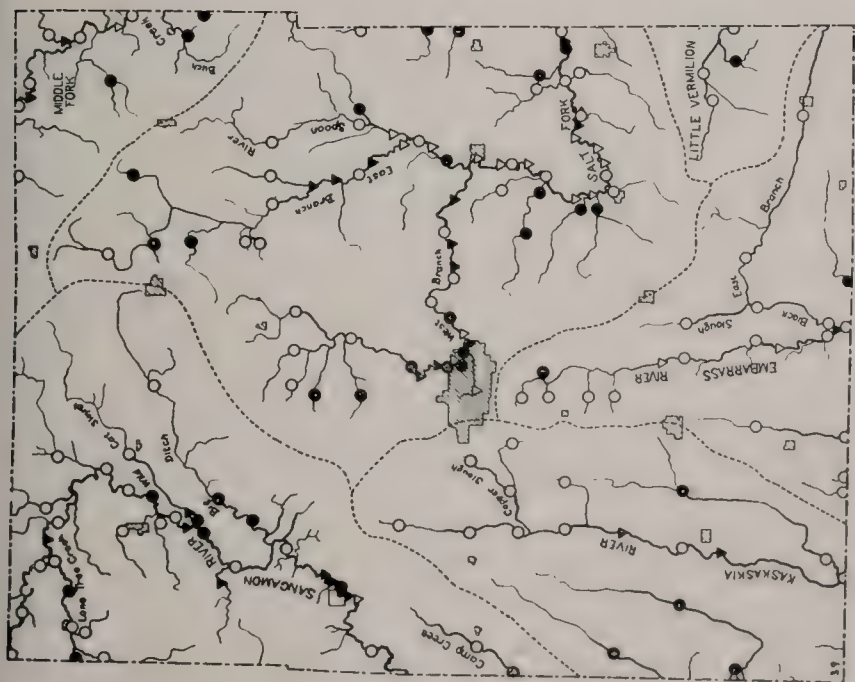
Map 36. Distribution of *Fundulus notatus*—Top-minnow.Map 35. Distribution of *Eox vermiculatus*—Grass pike.

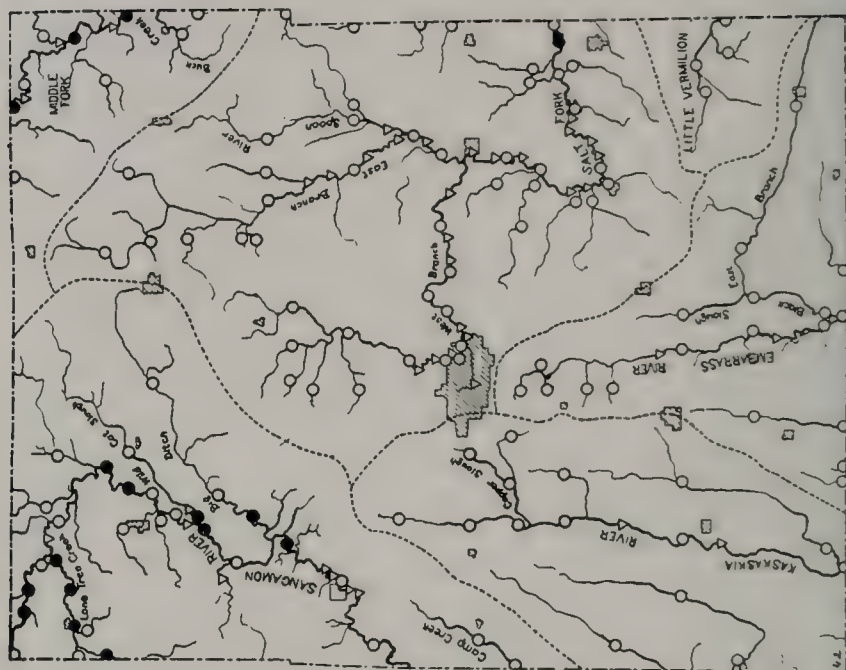


Map 38. Distribution of *Iphredodentus sayanus* - Pirate-perch.

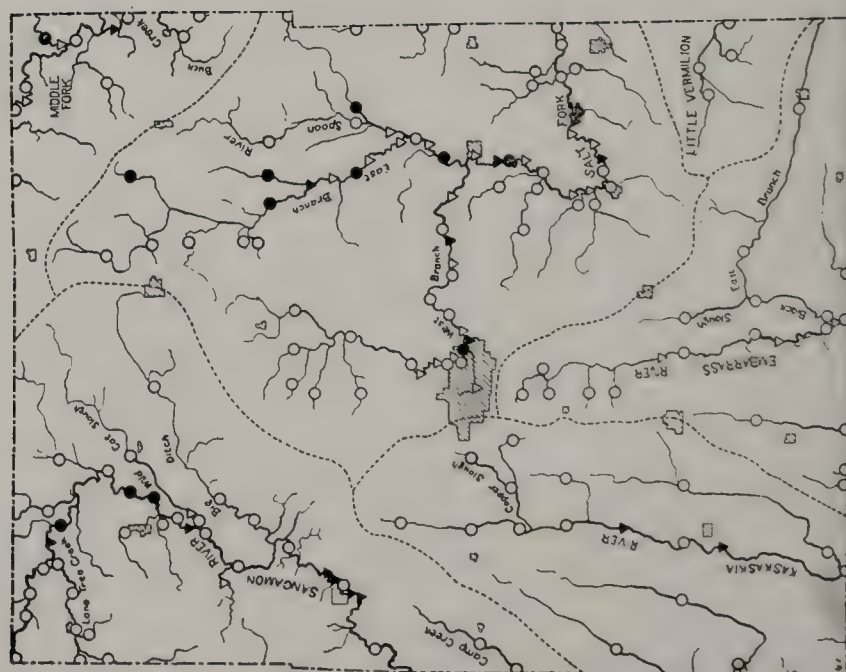


Map 37. Distribution of *Labidesthes sicculus* - Brook silverside.

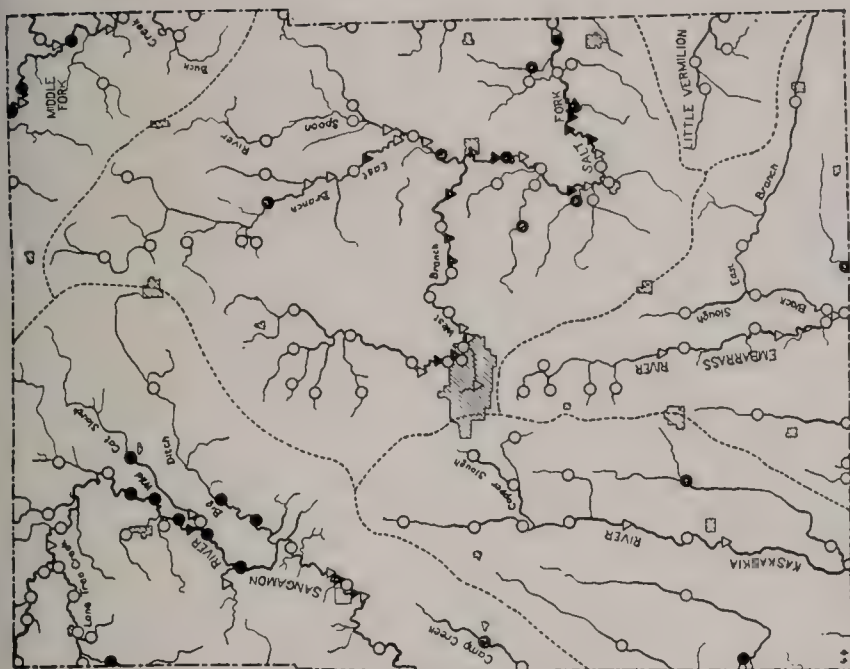
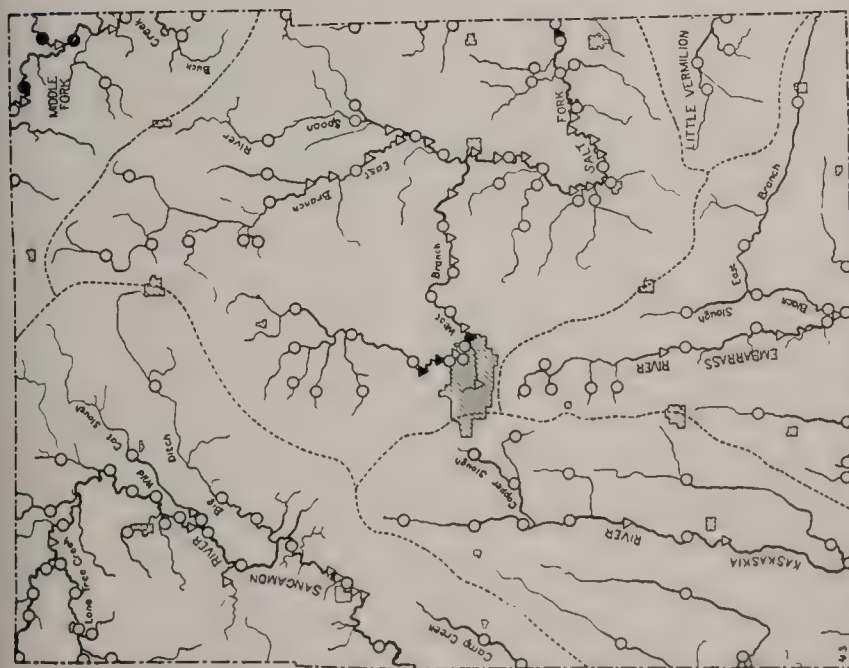
Map 40. Distribution of *Lepomis megalotis*—Long-eared sunfish.Map 39. Distribution of *Lepomis cyanellus*—Green sunfish.

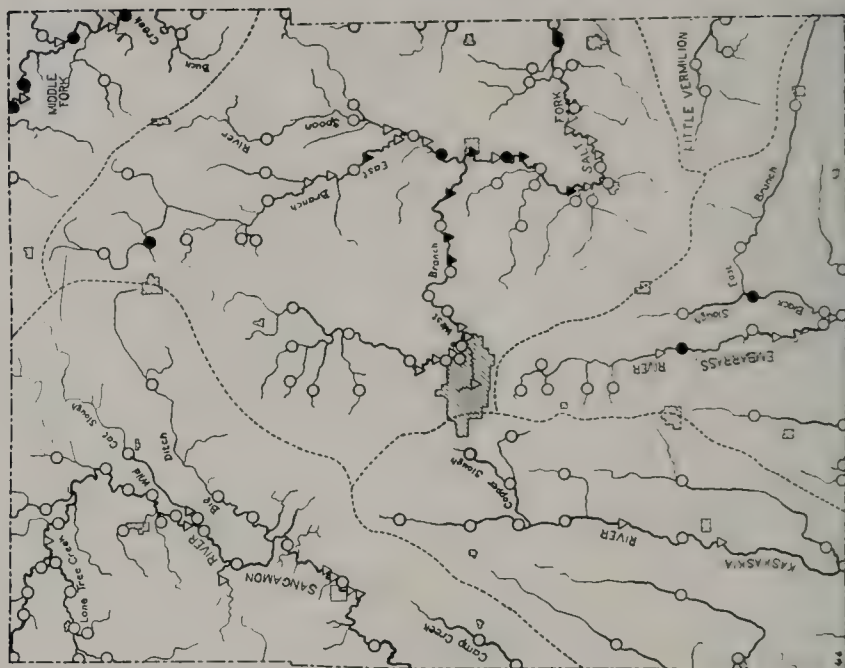


Map 42. Distribution of *Macropterus dolomieu*—Small-mouthed black bass.

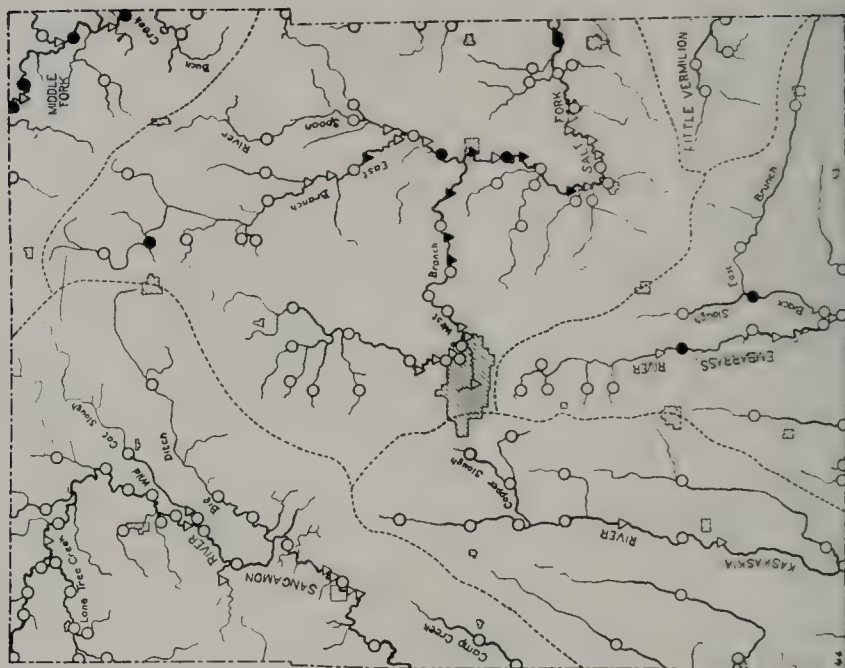


Map 41. Distribution of *Lepomis humilis*—Orange-spotted sunfish.

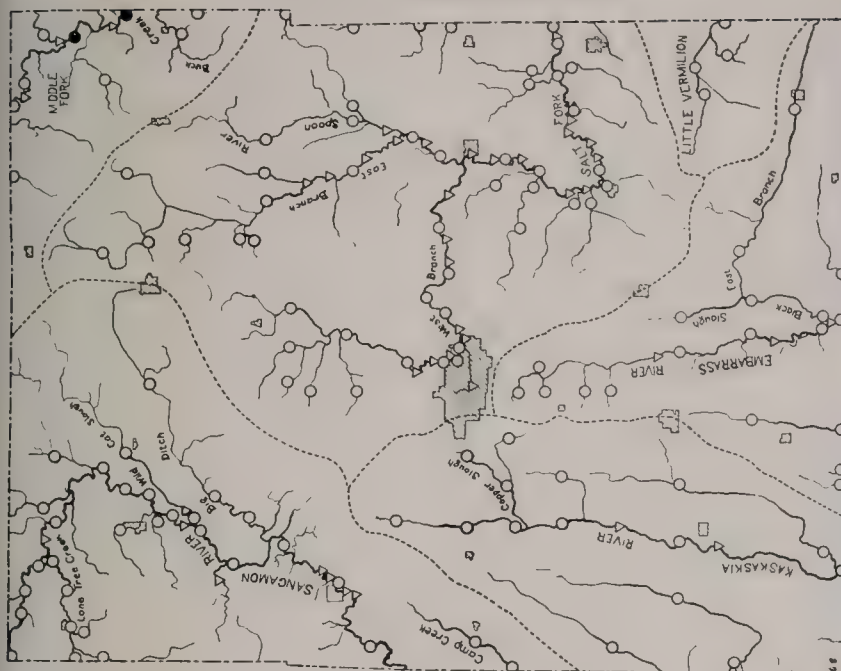
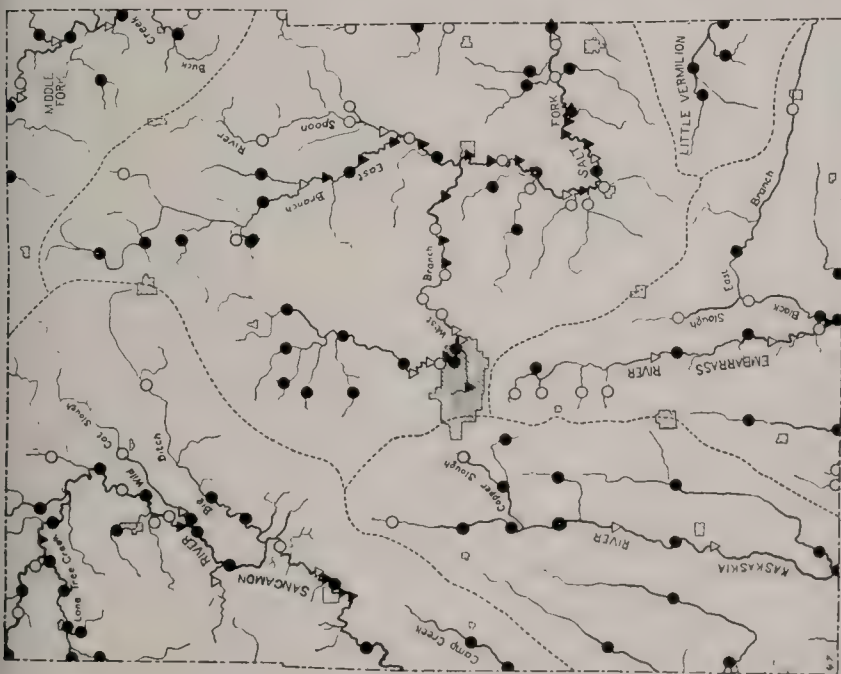
Map 44. Distribution of *Hadropterus aspro*—Black-sided darter.Map 43. Distribution of *Micropterus salmoides*—Large-mouthed black bass.

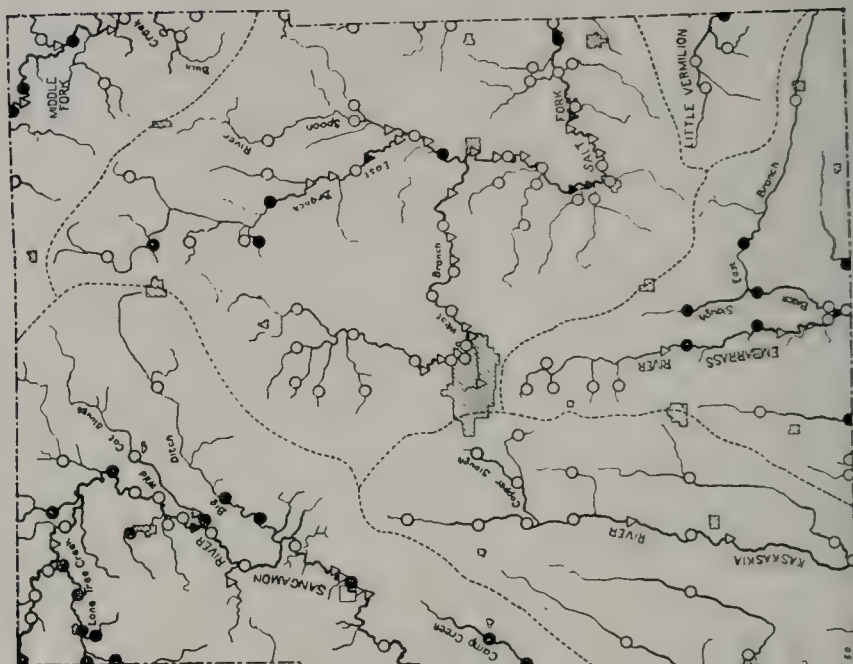
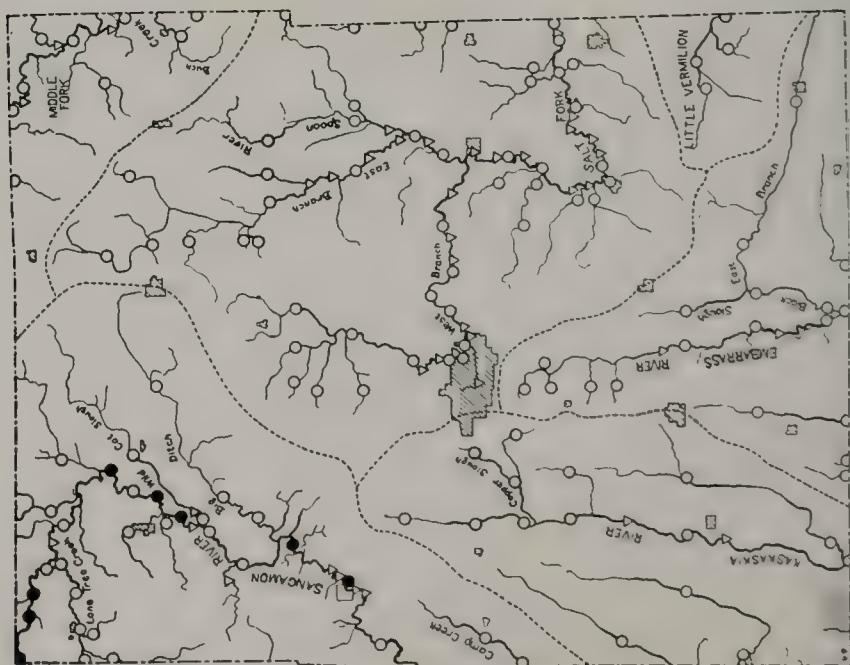


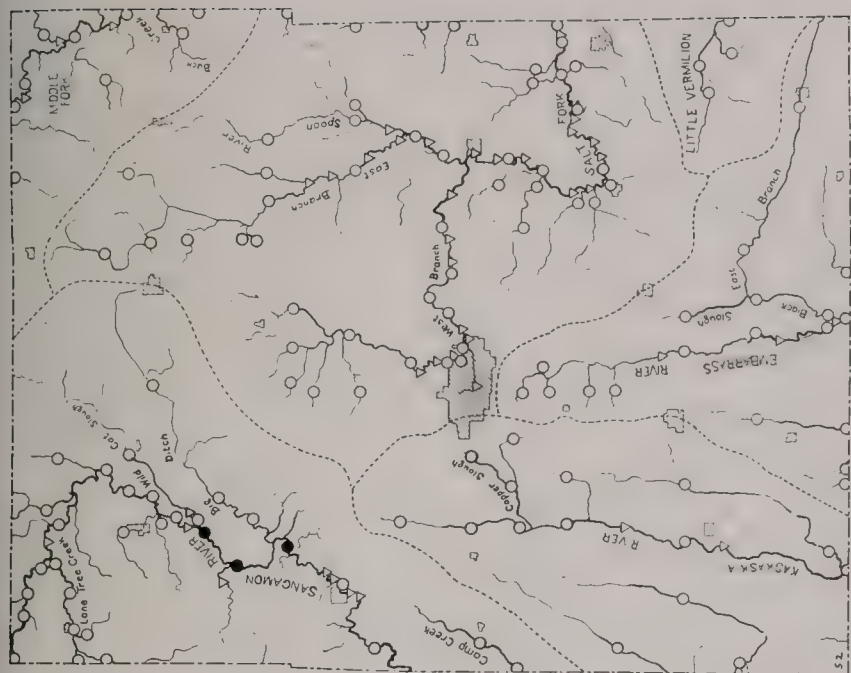
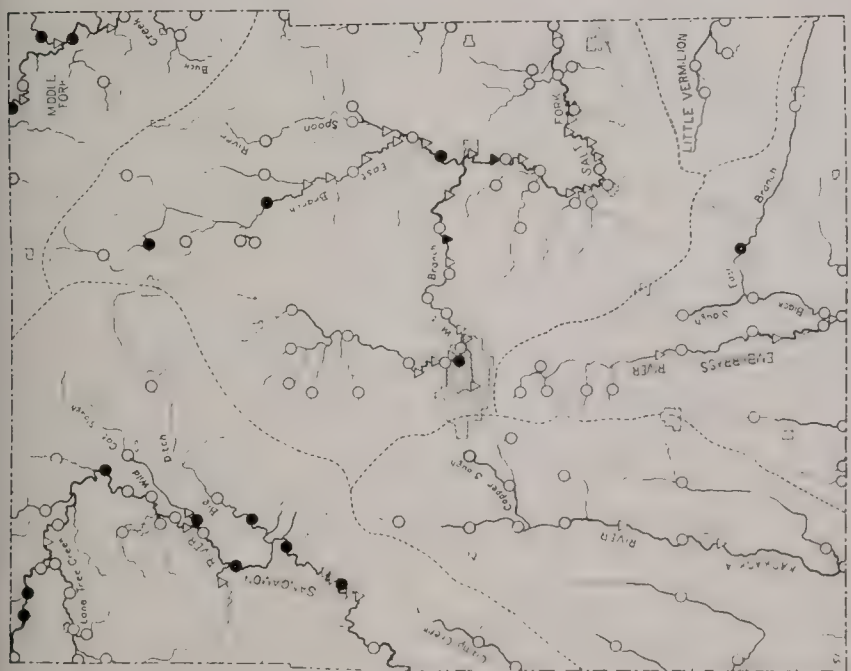
Map 45. Distribution of *Hadropterus phoxocephalus*—Sharp-nosed darter.



Map 46. Distribution of *Diplexis bleimoides*—Green-sided darter.

Map 48. Distribution of *Ammocrypta pellucida*—Sand darter.Map 47. Distribution of *Bolesoma nigrum*—Johnny darter.

Map 50. Distribution of *Etheostoma coeruleum*—Rainbow darter.Map 49. Distribution of *Etheostoma zonale*—Banded darter.

Map 52. Distribution of *Aplodinotus grunniens*—Sheepshead.Map 51. Distribution of *Etheostoma flabellare*—Fan-tailed darter.

APPENDIX

REVISED NAMES OF CHAMPAIGN COUNTY FISHES

Names used by Forbes and Richardson in "The Fishes of Illinois." 1909.	Names used by Jordan in "Manual of the Vertebrate Animals of the Northeastern United States." 13th ed., 1929.
<i>Anguilla chrysypa</i>	<i>Anguilla bostoniensis</i>
<i>Ictiobus cyprinella</i>	<i>Megastomatobus cyprinella</i>
<i>Carpiodes velifer</i>	<i>Carpiodes cyprinus</i>
<i>Catostomus nigricans</i>	<i>Hypentelium nigricans</i>
<i>Moxostoma breviceps</i>	<i>Moxostoma macrolepidotum</i>
<i>Pimephales notatus</i>	<i>Hyborhynchus notatus</i>
<i>Abramis crysoleucas</i>	<i>Notemigonus crysoleucas</i>
<i>Cliola vigilax</i>	<i>Ceraticthys vigilax</i>
<i>Notropis cayuga</i>	<i>Hybopsis heterolepis</i>
<i>Notropis blennioides</i>	<i>Hybopsis deliciosus</i>
<i>Notropis gilberti</i>	<i>Hybopsis dorsalis</i>
<i>Notropis illecebrosus</i>	<i>Hybopsis boops</i>
<i>Notropis whippelii</i>	<i>Cyprinella whippelii</i>
<i>Notropis cornutus</i>	<i>Luxilus cornutus</i>
<i>Notropis pilsbryi</i>	<i>Hydrophlox zonatus</i>
<i>Notropis umbratilis atripes</i>	<i>Lythrurus umbratilis cyanocephalus</i>
<i>Hybopsis amblops</i>	<i>Erinemus hyalinus</i>
<i>Hybopsis storerianus</i>	<i>Erinemus storerianus</i>
<i>Hybopsis kentuckiensis</i>	<i>Nocomis biguttatus</i>
<i>Leptops olivaris</i>	<i>Opladelus olivaris</i>
<i>Schilbeodes exilis</i>	<i>Rabida exilis</i>
<i>Schilbeodes miurus</i>	<i>Rabida miurus</i>
<i>Fundulus notatus</i>	<i>Zygonectes notatus</i>
<i>Lepomis cyanellus</i>	<i>Apomotis cyanellus</i>
<i>Lepomis miniatus</i>	<i>Sclerotis miniatus</i>
<i>Lepomis megalotis</i>	<i>Xenotis megalotis</i>
<i>Lepomis humilis</i>	<i>Allotis humilis</i>
<i>Lepomis pallidus</i>	<i>Helioperca incisor</i>
<i>Micropterus salmoides</i>	<i>Huro salmoides</i>
<i>Hadropterus phoxocephalus</i>	<i>Alvordius phoxocephalus</i>
<i>Hadropterus aspro</i>	<i>Alvordius maculatus</i>
<i>Diplesion blennioides</i>	<i>Etheostoma blennioides</i>
<i>Boleosoma camurum</i>	<i>Vaillantia camura</i>
<i>Ammocrypta pellucida</i>	<i>Vigil pellucidus</i>
<i>Etheostoma zonale</i>	<i>Nanostoma zonale</i>
<i>Etheostoma jessiae</i>	<i>Oligocephalus jessiae</i>
<i>Etheostoma coeruleum</i>	<i>Oligocephalus coeruleus</i>
<i>Etheostoma flabellare</i>	<i>Catonotus flabellaris</i>
<i>Boleichthys fusiformis</i>	<i>Hololepis fusiformis</i>

INDEX TO NAMES OF SPECIES

- Abramis crysoleucas*, 34, 35, 36, 44, 47, 53, 56; Map 15, p. 79.
Ambloplites rupestris, 29, 44.
Ameiurus melas, 26, 35, 39, 44, 47, 53; Map 31, p. 87.
Ameiurus natalis, 26, 44; Map 30, p. 86.
Amnocyrtus pellucida, 33, 45, 64; Map 48, p. 95.
Anguilla chrysypa, 17, 19, 45.
Aphredoderus sayanus, 28, 36, 45, 64; Map 38, p. 90.
Aplodinotus grunniens, 33, 39, 45; Map 52, p. 97.
 Banded darter, see *Etheostoma zonale*.
 Big-eyed chub, see *Hybopsis amblops*.
 Big-eyed minnow, see *Notropis illecebrosus*.
 Big-mouth buffalo, see *Ictiobus cyprinella*.
 Black bullhead, see *Ameiurus melas*.
 Black crappie, see *Pomoxis sparoides*.
 Blackfin minnow, see *Notropis umbratilis atripes*.
 Black-head minnow, see *Pimephales promelas*.
 Black-sided darter, see *Hadropterus aspro*.
 Black sucker, see *Catostomus commersonii*.
 Bluegill, see *Lepomis pallidus*.
 Blunt-nosed minnow, see *Pimephales notatus*.
 Blunt-nosed river carp, see *Carpionides difformis*.
Boleichthys fusiformis, 33, 45.
Boleosoma canurum, 33, 45, 48.
Boleosoma nigrum, 32, 36, 37, 45, 53, 56; Map 47, p. 95.
 Bream, see *Abramis crysoleucas*.
 Brindled stonecat, see *Schilbeodes miurus*.
 Brook silverside, see *Labidesthes sicculus*.
 Bullhead minnow, see *Cliola vigilax*.
Camptostoma anomalum, 23, 34, 35, 37, 40, 43, 47, 53, 56; Map 11, p. 77.
 Carp, see *Cyprinus carpio*.
Carpionides difformis, 21, 39, 43; Map 2, p. 72.
Carpionides velifer, 21, 37, 38, 43, 60; Map 3, p. 73.
Catostomus commersonii, 21, 35, 36, 37, 38, 39, 40, 43, 47, 49, 53, 56; Map 6, p. 74.
Catostomus nigricans, 21, 37, 38, 43; Map 7, p. 75.
 Cayuga minnow, see *Notropis cayuga atrocaudalis*.
Chaenobryttus gulosus, 29, 44.
 Channel-cat, see *Ictalurus punctatus*.
 Chub-sucker, see *Erimyzon succetta oblongus*.
Cliola vigilax, 23, 44, 64; Map 16, p. 79.
 Common red-horse, see *Moxotoma aureolum*.
 Common shiner, see *Notropis cornutus*.
 Common sucker, see *Catostomus commersonii*.
 Creek Chub, see *Semotilus atromaculatus*.
Cyprinus carpio, 23, 39, 44; Map 10, p. 76.
Diplesion blennioides, 32, 37, 45, 64, 65; Map 46, p. 94.
Dorosoma cepedianum, 19, 39, 45; Map 1, p. 72.
 Dough-belly, see *Camptostoma anomalum*.
 Eel, see *Anguilla chrysypa*.
Ericymba buccata, 25, 35, 37, 40, 44, 47, 48, 53, 56, 62, 65; Map 24, p. 83.
Erimyzon succetta oblongus, 21, 34, 36, 43, 47, 53, 56; Map 4, p. 73.
Esox vermiculatus, 27, 35, 36, 45, 53; Map 35, p. 89.
Etheostoma coeruleum, 33, 37, 45, 64; Map 50, p. 96.
Etheostoma flabellare, 33, 37, 45, 53, 64; Map 51, p. 97.
Etheostoma jessiae, 17, 33.
Etheostoma zonale, 33, 37, 45, 64, 65; Map 49, p. 96.
 European carp, see *Cyprinus carpio*.
 Fan-tailed darter, see *Etheostoma flabellare*.
 Fathead minnow, see *Pimephales promelas*.
 Fiddler, see *Ictalurus punctatus*.
 Fine-scaled sucker, see *Catostomus commersonii*.
Fundulus notatus, 28, 36, 45, 60; Map 36, p. 89.
 Garman's sunfish, see *Lepomis miniatus*.
 Gilbert's minnow, see *Notropis gilberti*.
 Gizzard-shad, see *Dorosoma cepedianum*.
 Golden shiner, see *Abramis crysoleucas*.
 Goggle-eye, see *Ambloplites rupestris*.
 Goujon, see *Leptops olivaris*.
 Grass pike, see *Esox vermiculatus*.
 Green-sided darter, see *Diplesion blennioides*.
 Green sunfish, see *Lepomis cyanellus*.
Hadropterus aspro, 32, 45; Map 44, p. 93.
Hadropterus phoxocephalus, 32, 45; Map 45, p. 94.
 High-back buffalo, see *Ictiobus bubalus*.

- Hiodon tergisus*, 19, 45.
 Hogsucker, see *Catostomus nigricans*.
 Horned dace, see *Semotilus atromaculatus*.
 Horned pout, see *Ameiurus mclasi*.
 Horned shiner, see *Notropis cornutus*.
 Horny-head, see *Hybopsis kentuckiensis*.
Hybognathus nuchalis, 23, 43, 64, 66, Map 12, p. 77.
Hybopsis amblopsi, 25, 37, 44, 64; Map 27, p. 85.
Hybopsis kentuckiensis, 26, 36, 37, 38, 40, 44, 56, 67, 68, 69, 71; Map 28, p. 85.
Hybopsis storerianus, 17, 26.
Ictalurus punctatus, 26, 37, 38, 39, 44; Map 29, p. 86.
Ictiobus bubalus, 17, 20.
Ictiobus cyprinella, 20, 39, 43.
Ictiobus urus, 20, 43.
 Johnny darter, see *Boleosoma nigrum*.
 Kentucky chub, see *Hybopsis kentuckiensis*.
Labidesthes sicculus, 28, 45, 53, 60, 64; Map 37, p. 90.
 Large-mouthed black bass, see *Micropterus salmoides*.
Lepomis cyanellus, 30, 35, 36, 38, 44, 53, 56; Map 39, p. 91.
Lepomis humilis, 30, 38, 44, 53, 64; Map 41, p. 92.
Lepomis megalotis, 30, 36, 38, 44, 53; Map 40, p. 91.
Lepomis miniatus, 30, 44, 53.
Lepomis pallidus, 30, 44, 53.
Leptops olivaris, 17, 27, 44.
 Little pickerel, see *Esox vermiculatus*.
 Log perch, see *Percina caprodes*.
 Long-eared sunfish, see *Lepomis megalotis*.
Micropterus dolomieu, 30, 38, 44; Map 42, p. 92.
Micropterus salmoides, 31, 39, 44; Map 43, p. 93.
Minytrema mclainops, 21, 43, 66; Map 5, p. 74.
 Mongrel buffalo, see *Ictiobus urus*.
 Moon-eye, see *Hiodon tergisus*.
Moxostoma anisurum, 21.
Moxostoma aureolum, 21, 37, 38, 39, 43; Map 8, p. 75.
Moxostoma breviceps, 21, 38, 39, 43; Map 9, p. 76.
 Mud-cat, see *Leptops olivaris*.
Notropis atherinoides, 25, 43, 64; Map 22, p. 82.
Notropis blennioides, 24, 38, 40, 43, 53, 56; Map 17, p. 80.
Notropis cayuga atrocaudalis, 24, 43.
Notropis cornutus, 25, 36, 37, 38, 40, 43, 56, 60, 67, 68, 69, 71; Map 20, p. 81.
Notropis gilberti, 24, 43, 64, 65; Map 18, p. 80.
Notropis illecebrosus, 24, 43, 64, 65.
Notropis pilsbryi, 25, 43; Map 21, p. 82.
Notropis umbratilis atripes, 25, 37, 40, 43, 53, 56, 60; Map 23, p. 83.
Notropis whipplei, 24, 37, 38, 40, 43, 53, 56, 60; Map 19, p. 81.
Noturus flavus, 27, 37, 44, 60; Map 32, p. 87.
Opsopocodus emiliae, 23, 44.
 Orange-spotted sunfish, see *Lepomis humilis*.
Percina caprodes, 32, 37, 45.
Phenacobius mirabilis, 25, 37, 44; Map 25, p. 84.
 Pilsbry's minnow, see *Notropis pilsbryi*.
Pimephales notatus, 23, 34, 35, 36, 37, 38, 40, 43, 47, 53, 56; Map 14, p. 78.
Pimephales promelas, 23, 43, 64, 65; Map 13, p. 78.
 Pirate-perch, see *Aphredoderus sayanus*.
Pomoxis annularis, 29, 38, 44.
Pomoxis sparoides, 29, 39, 44.
 Quillback, see *Carpiodes velifer*.
 Rainbow darter, see *Etheostoma caeruleum*.
 Red-mouth buffalo, see *Ictiobus cyprinella*.
 Red-tail, see *Moxostoma breviceps*.
 Rock bass, see *Ambloplites rupestris*.
 Round buffalo, see *Ictiobus urus*.
 Sand darter, see *Ammocrypta pellucida*.
Schilbodes exilis, 27, 44.
Schilbodes gyrinus, 27, 44, 64; Map 33, p. 88.
Schilbodes miurus, 27, 44, 64, 65; Map 34, p. 88.
Semotilus atromaculatus, 25, 34, 35, 36, 37, 40, 44, 47, 48, 53, 56, 65; Map 26, p. 84.
 Sharp-nosed darter, see *Hadropterus phoxocephalus*.
 Sheephead, see *Aplodinotus grunniens*.
 Shiner, see *Notropis atherinoides*.
 Short-headed red-horse, see *Moxostoma breviceps*.
 Silver chub, see *Hybopsis amblopsi*.
 Silver carp, see *Carpiodes velifer*.
 Silverfin, see *Notropis whipplei*.
 Silver-mouthed minnow, see *Ericymba buccata*.
 Silvery minnow, see *Hybognathus nuchalis*.
 Slender stonecat, see *Schilbodes exilis*.
 Small-mouthed black bass, see *Micropterus dolomieu*.

- Small-mouth buffalo, see *Ictiobus bubalus*.
Snub-nosed minnow, see *Opsopocodus emiliae*.
Spotted sucker, see *Minytrema melanops*.
Steel-colored minnow, see *Notropis whipplii*.
Stonecat, see *Noturus flavus*.
Stone-roller, see *Catostomus nigricans*.
Storer's chub, see *Hybopsis storerianus*.
Straw-colored minnow, see *Notropis blennioides*.
Striped sucker, see *Minytrema melanops*.
Sucker, see *Catostomus commersonii*.
Sucker-mouthed minnow, see *Phenacobius mirabilis*.
Sweet sucker, see *Erismyzon sucetta oblongus*.
Tadpole cat, see *Schilbeodes gyrinus*.
Toothed herring, see *Hiodon tergisus*.
Top-minnow, see *Fundulus notatus*.
Warmouth bass, see *Chaenobryttus gulosus*.
White crappie, see *Pomoxis annularis*.
White-nosed sucker, see *Moxostoma anisurum*.
White perch, see *Aplodinotus grunniens*.
White sucker, see *Moxostoma aureolum*.
Yellow bullhead, see *Ameiurus natalis*.
Yellow cat, see *Leptops olicaris*.

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RECORDS OF SPRING MIGRATION OF BIRDS AT URBANA, ILLINOIS 1903-1922*

FRANK SMITH

The chief object in view in the preparation of this paper has been to make available to those interested certain data connected with spring bird migration activities in East Central Illinois in the vicinity of Urbana.

Historical.—A regular course of instruction at the University of Illinois involving field work in ornithology was given by the writer in the spring of 1903 and annually thereafter for more than 20 years. Although he had been interested in birds in a general way for a number of years, their study had not been his major field of research and he was led to offer such a course, in part, because of the growing interest in bird study in some schools of the state and hence the need for an opportunity for the preparation of persons desiring to take charge of such work. During the first year records of the numbers of the various kinds of birds seen on each of the field trips were made and filed, but without any very definite plans for their further use. At a meeting of the American Association for the Advancement of Science in December, 1903, the writer learned from Dr. C. C. Adams, then Curator of the Museum of the University of Michigan, of the observation by N. A. Wood that a study of weather maps during the spring migration in the Ann Arbor region enabled one to predict with a considerable degree of certainty the "bird waves" when unusually large numbers of arrivals of species and individuals are recorded. A desire to learn whether there might be such a definite correlation in Eastern Illinois between the migration activities and certain kinds of weather conditions led to definite plans for daily observation trips throughout the spring migration season and including as wide a range of habitats as feasible. Especial effort was made to have the dates when representatives of the various migratory species were first seen correspond as

* Contributions from the Zoological Laboratory of the University of Illinois, No. 380.

closely as possible with the dates of actual first arrival. The cooperation of competent and interested observers who made records in different areas in the vicinity aided materially in accomplishing this result. Among these collaborators at various times were advanced students who were working on problems in which such observations were a more or less important part of their work. Included in the list of those who were especially helpful were A. O. Gross and T. E. Musselman, who have since contributed to our knowledge of Illinois ornithology, and F. C. Gates, well known for his work in plant ecology.

Since the correlation between migration flights and certain kinds of weather conditions was the object of study, special effort was made to obtain records of the first appearance of birds of the various species in the particular areas available for daily observation rather than in more remote areas which might be more attractive to birds of some species and perhaps have earlier arrivals, but to which it was not practicable to make daily trips. It is quite probable that in wooded areas along the banks of larger streams with bottom-land ponds or lakes and with marshy areas, the dates of arrival may have been somewhat earlier for some species of birds than the dates given in the following table. More favorable conditions attracting larger numbers of individuals of any particular kind are quite likely to result in earlier records for the observer who can make daily trips to such areas.

During the period of 1903-1922 there were extensive changes in the environmental conditions of some of the areas studied which had a marked effect on their bird faunas. With some species a marked adverse change in environment has been accompanied by a reduction from a large number of records per annum to a much smaller number. This has sometimes resulted in the average of the "first seen" records for the later years being several days or even a week or more later than that for the years when the species was abundantly represented. In a few cases of this kind it has seemed advisable to omit some of such abnormally late records when determining the median date of the records for use in the following tabular list.

Areas in which records were made.—The areas most thoroughly studied were necessarily those readily accessible from the university campus, since the records were made chiefly by those in charge of sections of the classes in ornithology while doing field work, or by those making early-morning trips. In either case it was not feasible to spend very much time in journeying to places too far removed.

One important source of records was an artificially forested area of about 15 acres, locally known as the Forestry, which is a part of the campus. During the first few years of the period discussed,

the roadway on the east side of this area was bordered on each side by hedges, and the land on the east side was used by the owners chiefly for orchards and pasture. Shrubbery and brush heaps were common, and the character of the environment made the region very attractive to many of the migrant species. In the Forestry itself there was considerable shrubbery and occasional brush heaps.

With the passing of the years and the great increase in the development of the university and the growth of the neighboring city, there was brought about the disappearance of hedges, brush heaps, and much of the shrubbery; the pastures were replaced by dooryards, and in the Forestry itself the trees were trimmed high and the forest floor cleaned up in such a manner as to make it far less attractive to many of the ground-feeding species. A natural result of such changes has been that most of the birds of some of these species have sought more attractive localities and the records of dates when they were first seen have been less reliable for indicating the time of their first arrival in the region.

A cemetery lying south of the university campus is another definite area which was regularly visited and which supplied a quite important share of the records. A very considerable number of large trees scattered through the area attracted a good many kinds of birds, while some hedges and considerable shrubbery attracted others. In the earlier years many of the burial lots were surrounded by hedges and contained much shrubbery, but the tendency in recent years has been to eliminate the hedges and most of the shrubbery, with resulting diminution in the numbers of some species of birds attracted by such an environment.

One very important area regularly visited contains what is locally known as Crystal Lake. It was the chief source of records for species having a preference for stream, lake, and marsh environments. It is also the area which has suffered most, from the ornithologist's point of view, because of changes affecting the environmental conditions. The region about Urbana and the University of Illinois has a slightly higher altitude than most of the adjacent territory and is without natural lakes, while the streams are mostly ditches and merely the beginnings of water-courses that become rivers elsewhere. One of these streams known locally as Salt Fork, has its origin a few miles north of Urbana and flows through the northeastern part of the city, then has an easterly course and is one of the tributaries of the Vermilion River. At some time in the earlier history of Urbana, a dam several feet high had been built across the stream in the northeastern part of the city, which resulted in the formation of an artificial lake of several acres in extent

(Crystal Lake) and also produced some tracts with marsh-like conditions. The banks of the lake were adapted to the needs of shore birds, and considerable numbers of coots, ducks, and other water birds were also regular visitors during the migration seasons. The stream above the lake had a meandering course through some wooded tracts, and the patches of willows and shrubbery along its banks made habitats that were attractive to birds of quite a large number of species.

Extensive changes made in this area in 1908 greatly altered the environmental conditions, with resulting changes in the bird life. For the more effective drainage of farm lands north of the city, an extensive drainage ditch was dug that replaced the old stream bed, but had a much more direct course and had steep, bare banks many feet in height. The part of the old stream bed where the lake had been formed was not included in the course of the ditch, but with the aid of the dredge a long curved excavation was made in the area that had been covered by the lake, which had been included in a city park. This substitute for the former lake received its water supply from the drainage ditch and had steep banks which were later mostly covered by shrubbery. The low marsh-like tracts and muddy flats attractive to shore birds were eliminated, and although the area has been successfully developed for park purposes, there is little to attract shore and water birds and several other kinds formerly found in the region.

General considerations.—In the accumulation of the following data it soon became obvious that it is sometimes difficult to be certain of accuracy in determining the "first seen" dates. Frequently one may not have an opportunity for a sufficiently careful detailed study of a specimen because of intervening brush or foliage, or because of its timidity and hasty departure. In making use of data furnished by other observers one cannot always be sure that they had sufficient knowledge to allow accurate identification of all kinds seen or that they listed only those which furnished an opportunity for an adequate study. In the preparation of the following data it has been the usual practice to omit the records that were considered doubtful.

In a study of the bird fauna of a region like the one under consideration, one must expect to deal with some species of which specimens are rarely seen, and not infrequently there will be but one or two records in a season and for some species but one or two records for the entire period. Such records may be of but little use in an attempt to determine the earliest and latest limits of a normal migration period for the species. The lack of suitable environments for many species of water birds accounts for the paucity of records for some species, although they may be common in more favorable localities in the same county.

Irregularities in the migration activities of birds of some species have been noticed that are similar to those recorded in other regions. Several species normally rated as summer residents have been represented by a few individuals which have stayed in the region during one or more winters. The Mourning Dove, Red-headed Woodpecker, Red-winged Blackbird, Robin, Bluebird, and others are examples. The Song Sparrow is represented throughout the year although presumably all of the individuals are migratory. Its summer and winter ranges overlap in this region, and hence it may be listed as a permanent resident, although the majority of the individuals seen are annual visitants, while a few are summer residents and a few others are winter residents. The Mockingbird seems to have been altering its winter range somewhat. February 18, 1906, and March 28, 1908, are the only records of its being seen earlier than April during any year preceding the winter of 1917/1918. Specimens were seen that winter and in each succeeding winter except that of 1918/1919. They were frequently seen in midwinter feeding in hedges and asparagus beds of city dooryards and gardens.

Lists of recorded species and varieties.—Of the 229 different kinds on our records, the names of all but eight may be found in the tabular list which follows. Four species of especially irregular occurrence and not in that list include the Snowy Owl and Golden Eagle, of each of which specimens were taken in November of two different years; the Bald Eagle, seen in March of 1905 and 1920; and the Duck Hawk, of which a specimen was taken in May of 1908. F. C. Gates made records of four other species as follows: Whistling Swan, April 23, 1908; Little Blue Heron, May 17, 1908; Sandhill Crane, May 11, 1910; and Semipalmated Sandpiper, April 25, 1908. For the convenience of those who may be interested in other than migrant species, the names of all birds regularly seen have been included in the list.

The records for most of the migratory species that are listed in the following table include: (*column 1*) the earliest date record of any one of the years; (*column 2*) a median "first seen" date record, which is the median date for those recognized as summer residents and annual visitants; (*column 3*) a median "last seen" record for winter residents and annual visitants; and (*column 4*) a latest spring record for any one of the years. The month is indicated by a Roman numeral and the day by an Arabic numeral. The number of years in which any given species was recorded (*column 5*) is preceded in some instances by a lesser number which indicates the number of years of which "first seen" records were used in determining the median date. This lesser number occurs with some species which were represented during the

winters of some years by a few specimens and also with certain other kinds which in some years had but one or few records and these late in the season. Symbols indicate the migratory group to which each species belongs (*column 6*), as follows: *A. V.* indicates annual visitants that spend the summers further north and the winters further south; *W. R.*, winter residents; *S. R.*, summer residents; and *P. R.*, permanent residents, including non-migratory forms and also certain migratory forms of which the summer and winter ranges overlap in the region and hence representatives are normally present at all times of the year even though the individuals are migratory. Interrogation marks after such symbols indicate uncertainty concerning the actual status of the species in this locality. Conflicting data in different papers dealing with the seasonal distribution of birds in the state are frequently found. A paper by Forbes and Gross (1923) has been especially helpful as a source of distribution data. During some years our data included no records made after June 1st., and hence the data for "last seen" records are less complete and reliable than those used for the "first seen" records.

Records of the Veery and its western variety, the Willow Thrush, are combined in the records of most years. This is due in part to the difficulty of ready distinction between the two forms in the field, and in part to the fact that in the earlier years of the period it was not realized that both forms were represented in the region. Similarly, the two species of Chickadees were not carefully distinguished in the earlier years of the period. Apparently the Carolina Chickadee is the one commonly found breeding and the other is common chiefly in the winter season. No attempt was made to separate the records of the House Wren and its variety, the Western House Wren; nor those of the Water Thrush and its variety, Grinnell's Water Thrush. For each of these species the records are listed under the name of the form which seems to be most commonly represented.

The writer has thought best to follow the example of Lynds Jones (1914) and use the median dates of "first seen" records rather than the average dates since they are less affected by extremes in earliest or latest records. The names of the species are listed in the same order as that followed in the American Ornithologists' Union (A. O. U.) Check List, by N. A. Wood (1907) in his report on bird migration in Michigan, and by Forbes and Gross (1923).

A comparison of the median dates of our "first seen" records with those of Hess (1910), which were obtained a few miles farther south and in the same county, reveals that in most cases the dates here listed are several days earlier than those of Hess. This is presumably due

to his lack of opportunity for daily observation trips and to his lack of sufficient aid from other observers, as intimated in his paper (p. 20).

For the convenience of those who are interested in the general subject of bird migration but who have not yet gained a detailed knowledge of the various phases of the subject or of the extensive literature dealing with them, it has seemed advisable to refer briefly to some facts which have a direct relation to the times at which various kinds of birds may be expected to appear in a region. Some kinds, including the Bluebird and the Meadowlark, usually appear in Central Illinois in February and often so early that their lives are in peril because of interference with their food supply by snow storms and freezing weather that may prevail after their arrival. The majority of birds that migrate arrive later in the season, and a good many kinds are not to be seen until May. The time of arrival is largely dependent on the location of the region in which the birds of any particular species spend the winter. Birds that winter in Southern Illinois or but little further south may be expected to arrive weeks before those that winter in the states along the Gulf Coast and months before those that winter in South America.

Birds of about seven-eighths of the species common in Illinois make annual journeys back and forth between their summer and winter homes, and birds of nearly one-half of the species have the areas occupied as summer and winter homes entirely separated, and hence they are annual visitants in the intervening territory. The birds of about one-third of our Illinois species journey beyond the boundaries of the United States to reach their winter homes. A few kinds winter in the West Indies, some in Mexico, others in Central America, while birds of about one-fifth of our species extend their journeys into South America. Included among these are some of the thrushes, warblers, swallows, flycatchers, cuckoos, and sandpipers. Hermit thrushes, phoebes, and myrtle warblers that winter in the states between Illinois and the Gulf of Mexico have much shorter distances to travel in spring than do some of the other thrushes, flycatchers, and warblers that winter in South America, and it is only natural that they should arrive in Illinois much earlier than do those that have much longer distances to travel.

A study of the daily records made during the spring migration periods under consideration shows a great lack of uniformity in the amount of migration activity on successive nights. On some mornings we have found new arrivals of as many as 15 or 20 species not previously seen that season, and such movements are often preceded and followed by nights of but little migratory activity. Such extensive

movements, or "bird waves," are not due to food conditions, but seem to be closely correlated with certain weather conditions. A careful study of the weather maps during the time when records were being made revealed that the greatest migratory activity in spring occurred at times when the weather maps showed an area of low barometric pressure approaching from the west, with the south winds and rising temperatures which normally accompany such movements. Definite illustrations of such correlation will be found in two papers by the writer (1917 and 1921). In the latter of these two papers (Illinois Birds as Travellers) there are also memoranda on winter homes of certain kinds of Illinois birds and on the routes followed in the journeys to and from them. In the use of this latter paper much confusion may be avoided by the correction of an unfortunate error made in publication: the reference in the text to Fig. 1 should be to Fig. 3, and the one to Fig. 3 should be to Fig. 1.

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A. O. U. No.	Common name of species	1 Earliest date record	2 Median of "first seen" records	3 Median of "last seen" records	4 Latest spring record	5 Number of years	6 Migratory group
3	Horned Grebe	III-22			IV-29	2	A. V. ?
6	Pied-billed Grebe	III-10	III-26			(18)20	S. R.
7	Loon	IV-25				1	W. R. ?
51	Herring Gull	I-6	III-13		V-10	(8)10	W. R. ?
54	Ring-billed Gull	IV-1			V-7	1	W. R. ?
69	Forster's Tern	V-8				1	A. V. ?
77	Black Tern	V-7				1	A. V. ?
120	Double-crested Cormorant	IV-11			IV-25	2	A. V.
125	White Pelican	V-10			V-13	2	A. V.
129	Merganser	V-7				1	A. V. ?
131	Hooded Merganser	IV-29			V-24	5	S. R. ?
132	Mallard	I-23			V-3	11	P. R. ?
139	Green-winged Teal	III-6			III-30	2	A. V. ?
140	Blue-winged Teal	III-19	III-29	V-2	V-6	(8)10	S. R. ?
142	Shoveller	III-21			IV-26	3	A. V.
143	Pintail	II-25			III-12	2	A. V. ?
144	Wood Duck	III-8			V-5	4	S. R. ?
147	Canvas-back	III-10			V-1	2	A. V.
148	Scaup Duck	III-18			V-6	4	A. V.
149	Lesser Scaup Duck	III-4	III-22	V-6	V-24	10	A. V. ?
150	Ring-necked Duck	III-12				1	A. V. ?
153	Buffle-head	III-18			IV-5	3	W. R. ?
167	Ruddy Duck	III-2			IV-21	2	A. V.
171a	White-fronted Goose	III-8			III-17	2	A. V.
172	Canada Goose	II-8			III-27	3	A. V.
190	Bittern	III-30	IV-11		V-18	13	S. R. ?
191	Least Bittern	IV-26			V-18	5	S. R. ?
194	Great Blue Heron	III-12	III-30			15	S. R.
201	Green Heron	IV-9	IV-23			20	S. R.
202	Black-crowned Night Heron	III-25	IV-8			17	S. R.
208	King Rail	III-22				5	S. R.
212	Virginia Rail	IV-13			IV-28	2	S. R. ?
214	Sora	IV-22	IV-30			14	S. R.
219	Florida Gallinule	IV-25			V-17	5	S. R. ?
221	Coot	III-25	IV-1	V-1	V-14	(10)14	S. R. ?
228	Woodcock	III-15	III-27			(8)11	S. R.
230	Wilson's Snipe	III-23	IV-2	IV-29	V-9	12	A. V.
239	Pectoral Sandpiper	III-21	IV-8		V-1	8	A. V.
242	Least Sandpiper	IV-29	V-12		V-20	5	A. V.
254	Greater Yellow-legs	IV-11	IV-18		V-16	6	A. V.
255	Yellow-legs	IV-11	IV-16		V-15	8	A. V.
256	Solitary Sandpiper	III-31	IV-23	V-21	V-31	(16)19	A. V.
258a	Western Willet	V-2				1	A. V. ?
261	Upland Plover	IV-9	IV-18			(6) 8	S. R.
263	Spotted Sandpiper	IV-12	IV-26			20	S. R.
270	Black-bellied Plover	IV-21				1	A. V. ?
272	Golden Plover	III-23	IV-2		V-25*	(6) 8	A. V.
273	Killdeer	II-13	III-1			20	S. R.
274	Semipalmated Plover	V-4			V-15	5	A. V.
289	Bob-white	I-13				19	P. R.
305	Prairie Chicken	I-16				13	P. R.

* A crippled specimen.

A. O. U. No.	Common name of species	1 Earliest date record	2 Median of "first seen" records	3 Median of "last seen" records	4 Latest spring record	5 Number of years	6 Migratory group
316	Mourning Dove	I-14	III-12			(19)20	S. R.
325	Turkey Vulture	II-1	IV-1			(16)17	S. R.
331	Marsh Hawk	I-8				16	P. R.
332	Sharp-shinned Hawk	III-7	IV-3			11	P. R. ?
333	Cooper's Hawk	III-6	III-24			10	S. R.
337	Red-tailed Hawk	I-7				15	P. R.
339	Red-shouldered Hawk	II-8				10	P. R. ?
343	Broad-winged Hawk	II-21	IV-28			(16)17	S. R.
347a	Rough-legged Hawk	XII-14			II-19	4	W. R.
357	Pigeon Hawk	IV-15			V-12	3	A. V.
360	Sparrow Hawk	I-3				20	P. R.
364	Osprey	IV-25			V-20	5	S. R. ?
365	Barn Owl	IV-2				4	P. R.
366	Long-eared Owl	I-6				10	P. R.
367	Short-eared Owl	I-3		IV-5	IV-28	9	W. R.
368	Barred Owl	I-7				9	P. R.
372	Saw-whet Owl	II-23			IV-21	4	W. R.
373	Screech Owl	I-1				14	P. R.
375	Great Horned Owl	IV-9				2	P. R.
387	Yellow-billed Cuckoo	IV-27	V-5			(18)20	S. R.
388	Black-billed Cuckoo	V-5	V-13			20	S. R.
390	Belted Kingfisher	II-28	III-17			20	S. R.
393	Hairy Woodpecker	I-3				20	P. R.
394c	Downy Woodpecker	I-1				20	P. R.
402	Yellow-bellied Sapsucker	II-26	III-26	V-11	V-20	20	A. V.
406	Red-headed Woodpecker	I-8	IV-11			(19)20	S. R.
409	Red-bellied Woodpecker	I-6				19	P. R.
412a	Northern Flicker	I-3				20	P. R.
417	Whip-poor-will	III-30	IV-24			19	S. R.
420	Nighthawk	IV-24	V-7			20	S. R.
423	Chimney Swift	IV-12	IV-20			(18)20	S. R.
428	Ruby-throated Hummingbird	IV-17	V-9			20	S. R.
444	Kingbird	IV-20	IV-27			20	S. R.
452	Crested Flycatcher	IV-20	V-1			20	S. R.
456	Phoebe	III-5	III-17			(18)20	S. R.
459	Olive-sided Flycatcher	IV-29	V-12	V-25	VI-5	20	A. V.
461	Wood Pewee	IV-22	V-2			(14)20	S. R.
463	Yellow-bellied Flycatcher	V-4	V-14	V-26	VI-9	18	A. V.
465	Acadian Flycatcher	V-3	V-12			19	S. R.
466	Traill's Flycatcher	V-11	V-18			10	S. R.
467	Least Flycatcher	IV-19	IV-30	V-26	VI-11	(16)20	S. R. ?
474b	Prairie Horned Lark	I-1				20	P. R.
477	Blue Jay	I-1				20	P. R.
488	Crow	I-1				20	P. R.
493	Starling	II-4			II-12	1	Irreg.
494	Bobolink	IV-25	V-4	V-16	V-18	16	A. V.
495	Cowbird	II-4	III-11			(19)20	S. R.
498	Red-winged Blackbird	I-21	III-6			(19)20	S. R.
501	Meadowlark	II-14	II-26			20	S. R.
501.1	Western Meadowlark	III-18				1	S. R. ?

A. O. U. No.	Common name of species	1 Earliest date record	2 Median of "first seen" records	3 Median of "last seen" records	4 Latest spring record	5 Number of years	6 Migratory group
506	Orchard Oriole	IV-25	V-4			19	S. R.
507	Baltimore Oriole	IV-23	IV-29			(18)20	S. R.
509	Rusty Blackbird	I-19	III-8	V-2	V-22	(19)20	A. V.
511b	Bronzed Grackle	I-2	III-3			(12)20	S. R.
517	Purple Finch	II-16	IV-1	V-8	V-31	18	A. V.
.....	English Sparrow	I-1				20	P. R.
521	Crossbill	IV-1			IV-26	2	W. R. ?
522	White-winged Crossbill	III-9			III-10	1	W. R. ?
528	Redpoll	I-24			IV-22	5	W. R.
529	Goldfinch	I-8				19	P. R.
533	Pine Siskin	I-9		V-14	V-23	7	W. R.
534	Snow Bunting	II-5			IV-9	2	W. R.
536	Lapland Longspur	II-12			IV-21	3	W. R.
537	Smith's Longspur	III-29			V-12	2	A. V. ?
540	Vesper Sparrow	III-5	III-28			19	S. R.
542a	Savannah Sparrow	III-5	III-24	V-10	V-21	13	A. V.
546	Grasshopper Sparrow	III-15	IV-14			(13)16	S. R.
547	Henslow's Sparrow	IV-3	IV-14			(6) 8	S. R.
548	Leconte's Sparrow	III-23			V-13	5	A. V.
552	Lark Sparrow	III-27	IV-22			17	S. R.
554	White-crowned Sparrow	IV-1	IV-30	V-17	V-29	20	A. V.
558	White-throated Sparrow	I-14	III-19	V-19	V-26	(18)20	A. V.
559	Tree Sparrow	I-1		IV-8	IV-25	19	W. R.
560	Chipping Sparrow	III-8	III-23			20	S. R.
561	Clay-colored Sparrow	V-5				1	Irreg.
563	Field Sparrow	II-20	III-22			20	S. R.
567	Slate-colored Junco	I-1		V-4	V-23	20	W. R.
567f	Montana Junco	III-17				1	Irreg.
575a	Bachman's Sparrow	III-19	IV-6			(12)13	S. R.
581	Song Sparrow	I-1				20	P. R.
583	Lincoln's Sparrow	IV-1	V-3	V-15	V-28	19	A. V. ?
584	Swamp Sparrow	II-23	III-19			20	S. R.
585	Fox Sparrow	II-13	III-1	IV-15	IV-29	20	A. V.
587	Towhee	II-12	III-11			20	S. R.
593	Cardinal	I-1				20	P. R.
595	Rose-breasted Grosbeak	IV-22	IV-30			20	S. R.
598	Indigo Bunting	IV-25	V-3			20	S. R.
604	Dickcissel	IV-25	V-3			20	S. R.
608	Scarlet Tanager	IV-13	IV-30			20	S. R.
610	Summer Tanager	IV-20	V-1			(13)15	S. R.
611	Purple Martin	III-13	IV-9			(18)20	S. R.
612	Cliff Swallow	IV-12	IV-24			(6)10	S. R.
613	Barn Swallow	III-31	IV-25			16	S. R.
614	Tree Swallow	IV-5	IV-17			10	S. R.
616	Bank Swallow	IV-3	IV-20			(16)17	S. R.
617	Rough-winged Swallow	IV-14	IV-25			12	S. R.
618	Bohemian Waxwing	IV-14				1	Irreg.
619	Cedar Waxwing	II-11				20	P. R.
622e	Migrant Shrike	III-3	III-18			20	S. R.
624	Red-eyed Vireo	IV-23	V-6			20	S. R.
626	Philadelphia Vireo	V-2	V-12	V-21	V-27	19	A. V.
627	Warbling Vireo	IV-22	V-4			16	S. R.
628	Yellow-throated Vireo	IV-23	V-4			19	S. R.

A. O. U. No.	Common name of species	1 Earliest date record	2 Median of "first seen" records	3 Median of "last seen" records	4 Latest spring record	5 Number of years	6 Migratory group
629	Blue-headed Vireo	IV-22	IV-29	V-20	V-29	(14) 20	A. V.
631	White-eyed Vireo	IV-25	IV-29			(6) 7	S. R.
633	Bell's Vireo	V-1				6	S. R.
636	Black and White Warbler	IV-15	IV-24	V-21	VI-6	20	S. R. ?
637	Prothonotary Warbler	IV-22	V-2			(14) 17	S. R.
639	Worm-eating Warbler	IV-13			V-16	6	S. R. ?
641	Blue-winged Warbler	IV-29	V-4		V-21	9	S. R. ?
642	Golden-winged Warbler	V-1	V-6		V-19	(16) 18	A. V. ?
645	Nashville Warbler	IV-26	V-1	V-19	V-27	20	A. V.
646	Orange-crowned Warbler	V-11	V-13		V-22	4	A. V.
647	Tennessee Warbler	IV-25	V-11	V-21	VI-5	13	A. V.
648a	Northern Parula						
	Warbler	IV-27	V-9	V-15	V-19	15	S. R. ?
650	Cape May Warbler	IV-20	V-5	V-20	VI-4	19	A. V.
652	Yellow Warbler	IV-25	V-2			20	S. R.
654	Black-throated Blue Warbler	IV-25	V-5	V-17	V-26	20	A. V.
655	Myrtle Warbler	III-7	IV-9	V-18	V-24	20	A. V.
657	Magnolia Warbler	IV-14	V-2	V-24	VI-9	20	A. V.
658	Cerulean Warbler	V-20				1	S. R. ?
659	Chestnut-sided Warbler	IV-28	V-4	V-23	VI-5	20	A. V.
660	Bay-breasted Warbler	IV-30	V-8	V-23	VI-6	20	A. V.
661	Black-poll Warbler	IV-22	V-9	V-24	VI-11	20	A. V.
662	Blackburnian Warbler	IV-24	V-3	V-22	VI-9	20	A. V.
667	Black-throated Green Warbler	IV-8	IV-27	V-15	V-21	20	A. V.
671	Pine Warbler	IV-9	IV-23	V-10	V-23	19	S. R. ?
672	Palm Warbler	IV-17	IV-22	V-18	V-31	20	A. V.
673	Prairie Warbler	IV-26			V-15	4	S. R. ?
674	Oven-bird	IV-23	V-2			20	S. R.
675	Water-Thrush and						
675a	Grinnell's Water-Thrush	IV-14	IV-30	V-22	V-31	20	A. V.
676	Louisiana Water-Thrush	IV-29				2	S. R.
677	Kentucky Warbler	V-1	V-6			(9) 13	S. R.
678	Connecticut Warbler	V-4	V-17	V-25	VI-6	16	A. V.
679	Mourning Warbler	V-3	V-11	V-23	V-29	18	A. V.
681	Maryland Yellow-throat	IV-20	IV-29			20	S. R.
683	Yellow-breasted Chat	IV-29	V-4			17	S. R.
684	Hooded Warbler	IV-14				4	S. R.
685	Wilson's Warbler	IV-28	V-11	V-23	VI-1	19	A. V.
686	Canada Warbler	V-1	V-7	V-23	VI-3	(14) 19	A. V.
687	Redstart	IV-24	V-2			20	S. R.
697	Pipit	IV-25			IV-29	2	A. V.
703	Mecklingbird	I-1	IV-19			(11) 16	P. R. ?
704	Catbird	IV-20	IV-26			(16) 20	S. R.
705	Brown Thrasher	III-14	III-27			(19) 20	S. R.
718	Carolina Wren	I-7				7	P. R.
719	Bewick's Wren	III-6	III-25			20	S. R.

A. O. U. No.	Common name of species	1 Earliest date record	2 Median of "first seen" records	3 Median of "last seen" records	4 Latest spring record	5 Number of years	6 Migratory group
721	House Wren and	III-26	IV-21			20	S. R.
721a	Western House Wren						
722	Winter Wren	III-3	III-28	V-1	V-11	19	A. V.
724	Short-billed Marsh Wren	V-13				1	S. R. ?
725	Long-billed Marsh Wren	IV-5			V-22	9	S. R. ?
726	Brown Creeper	I-1		V-1	V-22	20	W. R.
727	White-breasted Nuthatch	I-1				18	P. R.
728	Red-breasted Nuthatch	I-3	III-3	V-14	VI-5	(11) 17	A. V.
731	Tufted Titmouse	I-7				19	P. R.
735	Chickadee	I-7			IV-25	9	W. R. ?
736	Carolina Chickadee	II-19				10	P. R. ?
748	Golden-crowned Kinglet	I-1		IV-26	V-14	20	W. R.
749	Ruby-crowned Kinglet	III-16	III-28	V-15	V-23	20	A. V.
751	Blue-gray Gnatcatcher	III-30	IV-14			20	S. R.
755	Wood Thrush	IV-23	IV-30			20	S. R.
756	Veery and	IV-24	IV-29	V-25	VI-5	(18) 20	A. V.
756a	Willow Thrush						
757	Gray-cheeked Thrush	IV-19	IV-29	V-25	VI-5	19	A. V.
758a	Olive-backed Thrush	IV-17	IV-25	V-27	VI-5	20	A. V.
759b	Hermit Thrush	III-22	III-31	V-5	V-17	(18) 20	A. V.
761	Robin	I-5	II-20			(13) 20	S. R.
766	Bluebird	I-22	II-23			(17) 20	S. R.

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
NATURAL HISTORY SURVEY

THEODORE H. FRISON, *Chief*

Vol. XIX.

BULLETIN

Article III.

The Plant Lice, or Aphidiidae, of Illinois

BY

FREDERICK C. HOTTES

AND

THEODORE H. FRISON



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CONTENTS

PART I

	PAGE
Introduction	125
Limitations	126
Acknowledgments	127
Structure	128
Life Histories	130
Distribution	135
Cyrus Thomas Collection.....	140
Designations of Types.....	141
Collection and Preservation of Material.....	144
Applied Control.....	145
Natural Control and Interrelations.....	147

PART II

Family Aphididae (with Key to Subfamilies).....	148
Subfamily Aphinae (with Key to Supertribes).....	149
Supertribe Lachnea (with Key to Genera).....	150
Genus Anoecia.....	151
Genus Cinara.....	153
Genus Eulachnus.....	157
Genus Longistigma.....	157
Genus Tuberolachnus.....	159
Supertribe Chaitophorea (with Key to Genera).....	160
Genus Amphiceridus.....	160
Genus Chaitophorus.....	160
Genus Clavigerus.....	165
Genus Gypsoaphis.....	167
Genus Paducia.....	167
Genus Periphyllus.....	170
Genus Plocamaphis.....	172
Genus Sipha.....	174
Supertribe Aphiea (with Key to Genera).....	175
Genus Alphitoaphis.....	175
Genus Aphis.....	176
Genus Asiphonaphis.....	225
Genus Brachycolus.....	228
Genus Brevicoryne.....	228
Genus Cavariella.....	229
Genus Cerosipha.....	229
Genus Hyalopteris.....	231
Genus Hysteroneura.....	232
Genus Rhopalosiphum.....	234
Genus Toxoptera.....	241
Supertribe Callipterea (with Key to Genera).....	242
Genus Calaphis.....	243
Genus Cepegillettea.....	246
Genus Drepanaphis.....	246
Genus Euceraphis.....	249
Genus Iziphya.....	250
Genus Melanocallis.....	251

	PAGE
Genus Monellia.....	252
Genus Myzocallis.....	254
Genus Neosymydobius.....	261
Genus Phyllaphis.....	264
Genus Saltusaphis.....	265
Genus Shenahweum.....	267
Genus Stegophylla.....	268
Genus Tamalia.....	268
Genus Thripsaphis.....	270
Genus Tuberculatus.....	271
Supertribe Macrosiphea (with Key to Genera).....	273
Genus Amphorophora.....	273
Genus Capitophorus.....	280
Genus Idiopterus.....	292
Genus Macrosiphum.....	293
Genus Microparsus.....	333
Genus Myzus.....	334
Genus Pentalonia.....	345
Genus Phorodon.....	345
Subfamily Eriosomatinae.....	345
Supertribe Eriosomea (with Key to Genera).....	345
Genus Asiphum.....	348
Genus Colopha.....	348
Genus Eriosoma.....	350
Genus Forda.....	354
Genus Geoica.....	356
Genus Georgiaphis.....	357
Genus Gobaishia.....	359
Genus Melaphis.....	359
Genus Mordwilkoja.....	360
Genus Neoprociphilus.....	361
Genus Pemphigus.....	363
Genus Prociphilus.....	370
Genus Thecabius.....	374
Genus Trifidaphis.....	374
Subfamily Mindarinae.....	374
Supertribe Mindarea.....	374
Genus Mindarus.....	374
Subfamily Hormaphidinae.....	375
Supertribe Hormaphea (with Key to Genera).....	375
Genus Hamamelistes.....	375
Genus Hormaphis.....	376

PART III

Keys to Species of Plant Lice Grouped with Reference to Host Plants:

Apple	378
Berries	379
Garden Flowers.....	379
Grain Crops.....	381
Greenhouse Plants.....	382
Legumes	383
Ornamental Shrubs.....	384
Peach, Plum, or Cultivated Cherry.....	387
Truck Crops.....	387
Vines	388
Host Index.....	389
Bibliography	404
Plates	418
Addenda	438
Index	439

THE PLANT LICE, OR APHIDAE, OF ILLINOIS

FREDERICK C. HOTES* AND THEODORE H. FRISON

PART I

INTRODUCTION

A cursory examination of the literature relating to any phase of the study of the plant lice, or Aphidae, is sufficient to show that Illinois has contributed much to our present knowledge of these small but nevertheless often destructive and biologically most interesting insects. In fact, all of the four State Entomologists of Illinois, Walsh, LeBaron, Thomas, and Forbes, have given them considerable attention and published much of a varied nature concerning them.

Benjamin Dann Walsh, the first official entomologist of Illinois (1867-1869), besides writing about the life histories and control of plant lice, described ten species which he thought to be new to science. William LeBaron, State Entomologist for five years (1870-1875), published the least concerning plant lice of any of the State Entomologists of Illinois, but even he went so far as to describe one plant louse which he thought to be new. The publications on plant lice of Cyrus Thomas, the third State Entomologist of Illinois (1875-1882), are without doubt the most important contributions to an understanding of the classification and bionomics of the plant lice of North America published prior to 1880. Succeeding Thomas came Stephen Alfred Forbes as State Entomologist from 1882 to 1917; and he, like his predecessors, recognized the importance of studies of plant lice. Besides the naming of several forms supposed to be new, he published much concerning the biology of the species attacking corn and strawberries, his studies of the species attacking corn being particularly noteworthy.

Apparently the study of plant lice has been so long and so inherently a page in the history of entomology in Illinois, that many others at one time or another connected with entomological investigations in the state have been drawn to the study of these insects. The numerous and valuable papers of Davis, Hart, and Weed are proof of this; the first mentioned, in fact, being one of the two greatest contributors to our knowledge of the plant lice of Illinois. Others, too, such as Shimer within the state, and Monell working close to our borders, without official connections with the work in Illinois, have helped to swell our knowledge of the plant lice. As a result of all of these studies, Illinois may well be thought of as one of the chief centers of aphidology in North America until within recent years.

In view of all of this previous work on plant lice in Illinois it may seem a bit paradoxical, then, to state that the present paper adds approximately one hundred species to our list of potential enemies, of

* Head of Department of Biology, James Millikin University, Decatur, Illinois, and Assistant Entomologist, Illinois State Natural History Survey, summers of 1928-1930.

which thirty-six species are new to science. The reason for this situation lies not in the fact that the plant lice of Illinois have been neglected in comparison with other political or geographical areas, but because of the wonderful and varied assortment of these insects within our boundaries, and the exceptional facilities and opportunities presented during the last three years for their intensive study.

Beginning in May, 1928, the Natural History Survey started a faunistic study of the plant lice occurring in Illinois, with the purpose of providing information concerning the number of kinds found in the state, their characteristics, distribution, host relationships, seasonal adjustments, importance as potential enemies, and a general concept of their life histories. To accomplish this program it was necessary at the very outset to plan a systematic inventory of the plant lice fauna of the state. Accordingly, a study was made of all published Illinois records of these insects, and the possibilities of extending this list, based upon a knowledge of the flora of Illinois and of plant lice recorded elsewhere, were considered.

Although many species had been recorded from the state, the Survey collection of these insects was very poor and, except for a few slide mounts, consisted of old material in poor condition preserved in vials and representing but a few species. Previous to extensive field work, this old material was remounted and as much of it salvaged as possible. Based upon a knowledge of zoo- and phytogeographical differences in the state, certain localities in diverse sections were selected as offering exceptional opportunities for enriching the Survey collection and increasing our general biological knowledge of the plant lice.

Field investigations were made during three summers, 1928-1930, beginning in May of each year. Collecting was first carried on in the southern part of the state, then the central part, and finally the northern part. This order was followed in spring and summer because of the seasonal differences exhibited between southern and northern Illinois, vernal conditions appearing in the latter section about two weeks later than in the former. In fall, these localities were usually visited in the reverse order. Each of these sections of the state was visited two or three times a year in order that various forms of the same species might be taken and no species overlooked because of different seasonal adjustments. Special attention was given to certain widely varied local habitats, such as the sand areas associated with Lake Michigan and the glacial drainage courses, the swamps and bogs in the northeastern counties, the cypress swamps in the extreme southern counties, and the widely distributed biotas of deciduous forest and the prairie or oak-grove savanna. Over 12,000 miles were traversed by automobile in our field work, the general routes followed being shown in Fig. 1.

To avoid unnecessary duplication in our collecting over a period of three summers, lists were prepared in advance of field trips giving the names of species previously taken in the locality about to be revisited. A somewhat similar scheme of preparing lists was used in checking up on the work in a restricted area over a period of a few days. After a certain number of species had been taken in a given area it was usually found expedient to shift to a new locality.

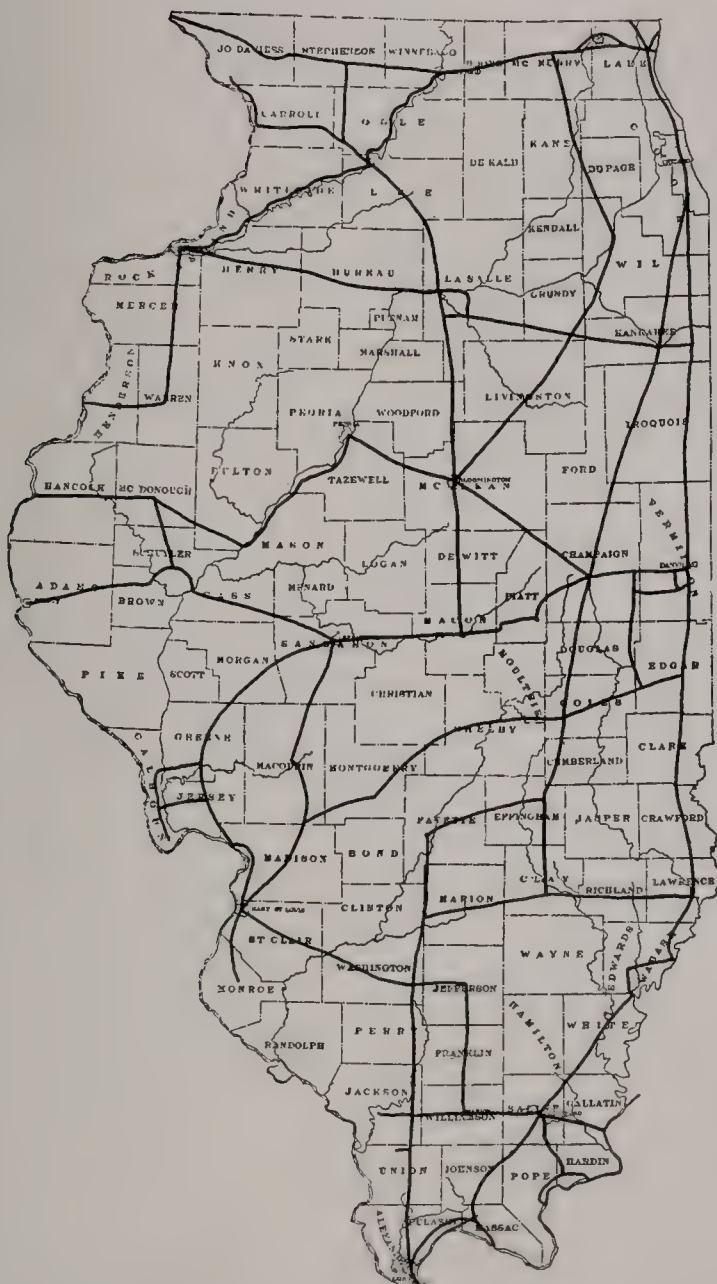


Fig. 1. Map of Illinois showing routes followed in making collections of plant lice in the state, May, 1928, to October, 1930. Many of the routes were traversed several times at different seasons of the same and different years.

LIMITATIONS

This paper is purely a faunistic or synoptic study of the plant lice of Illinois and is not to be considered as revisional or monographic in scope. Therefore, only those references are cited in the text which refer to the original description of the species, or which are necessary because of the introduction of new synonymy, or which provide an understanding of the specific names adopted in this paper. A revisional paper should summarize the literature of each species to date and pass upon the correctness of previous determinations recorded in the literature. This we have not attempted to do. As a result, some references in literature dealing with species by the same names as those used by us may refer to different aphids because of misidentifications upon our part or by others. We have tried, however, by careful studies of descriptions, comparisons with types in the Survey collection and elsewhere, and the submission of doubtful determinations to various specialists, to make our determinations as correct as possible.

The lack of comprehensive revisional papers in this group of insects has been a great handicap to such a study as the present because many nomenclatorial and taxonomic problems have had to be investigated and decisions made which are really within the field of the revisional paper. The voluminous and scattered literature, too, although providing an enormous fund of useful and indispensable information of varied extent, has presented some problems which previous revisional work would have simplified.

No attempt has been made to cite in the text all references regarding the species reported or to summarize all information in the literature. We have tried briefly to call attention to previous records from Illinois, and by the incorporation of a few statements or citations to give the general reader some insight into the interesting features in the life histories, classification, or problems of the various species discussed.

The keys have been prepared almost entirely on the basis of the alate viviparous females, since these forms are the ones usually taken in the field and since they usually present a better combination of characters for recognition than do the other forms. The ideal revisional paper would present keys to all forms. The keys given here are not devised to show phylogenetic relationships, even though at times they may do so; but they are intended primarily to make identifications as easy and simple as possible. If these keys are not all that might be desired, the difficulty of defining certain species and groups must be considered in addition to our own shortcomings. Again, it must be remembered that these keys are intended for the determination of plant lice found in Illinois, and for several obvious reasons they may prove misleading if used blindly in other parts of the country.

The problem of generic concepts has been a difficult one. In some cases it has seemed to us that certain proposed genera are more comparable to the subgenera, or unnamed groups and complexes, of other families or orders of insects than they are to genera. This was particularly forced upon our attention in the preparation of keys, and we have solved this problem to our own immediate satisfaction by re-

ducing to subgeneric status certain groups which were formerly considered as genera but which we could not sharply differentiate in our keys. For instance, although the genotype of *Illinoia* may be separated from some other not closely related *Macrosiphum* by a certain character, no real dividing place can be definitely established when a large number of species of *Macrosiphum* are compared. Therefore we have considered such complexes as true synonyms or subgenera.

Although a great deal of effort has been spent in making this paper as complete as possible, a few species have undoubtedly escaped our notice. The presence of some of these in Illinois may be predicted because of their known geographical range and the presence of their host plants in the state. The suggested outlines of the distribution in Illinois of many of the species listed, based upon our field work, are far from complete, but with a reasonable understanding of the range of the host plants and habits of the species, a fair idea of their zoogeographical distribution in the state can be obtained by an analysis of the data presented.

The aphid specialist will soon discover that the larger classificatory units used in this paper do not agree in every respect with the groupings used by others. In some cases this is due to differences of opinion in regard to the relationship of certain genera and, hence, their inclusion in larger groups where they previously have not been placed. In most comprehensive classifications the aphids are keyed first to subfamilies, then to tribes, then to subtribes, and finally to genera. Such an arrangement has much in its favor, particularly to the special student of aphids interested in their phylogeny, but in this faunistic paper, where the ready and simple determination of species is one of the chief aims, we have felt that the inclusion of supertribal groupings only, between the subfamilies and genera, has been an advantage.

Frequent citations are given in the keys to figures which have been incorporated to aid in identification. In many cases the figures cited refer to the identical genus or species mentioned in the key. In other instances, as a measure of expediency, we have cited figures which are not the identical genus or species referred to in the key. In other words, then, the figures cited in the keys refer to a condition rather than always to the identical species. The illustrations cited in descriptions and the general text, however, are based upon actual specimens of the species under consideration. It should be stated that the illustrations are not all drawn to the same scale, and different illustrations are, therefore, comparable only in regard to structural characteristics.

ACKNOWLEDGMENTS

The writers wish to express their appreciation of the voluminous published contributions by past and present writers to our knowledge of the biology and classification of the plant lice. Without this background it would have been impossible to complete a faunistic study of the plant lice of Illinois in the short time allotted to this project. For the loan of material and assistance in a variety of ways we are greatly indebted to the following: Dr. C. R. Cutright, Ohio Agricultural Ex-

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STRUCTURE

This is not the place for the presentation of a detailed description of the various features of the morphology of plant lice. It seems desirable, however, to include for the benefit of the general student a hypothetical figure of an aphid (Fig. 2), with the various parts labeled to correspond to the terminology used in the keys and descriptions, and a few drawings (Figs. 3 and 4), suggesting the possibilities of variation of color markings or patterns. It has been impossible in this paper to include color illustrations of the various species based upon live material, though the value of such illustrations cannot be denied (see Gillette and Palmer, 1924). The color descriptions, however, of most of the new species described in this paper have been made from live material.

For comprehensive discussions of the morphological characters presented by aphids, the reader is referred to papers by Baker (1915, 1917d, 1920), Jackson (1907), Patch (1909a), Santorn (1904), Swain (1919), Theobald (1926), Thomas (1879), Vickery (1908), and others. It is highly probable that systematic studies in the future will make more use of certain obscure characters which are now almost entirely neglected in systematic writings.

In preparing our descriptions we have uniformly omitted the word millimeter, or its customary abbreviation, mm, when stating measurements regarding length of body, comparative lengths of antennae, width of head across eyes, and so on. We have found it advantageous to use both a compound binocular microscope with high magnifications and a wide-field binocular microscope with low magnifications. While the former brings out clearly the more minute characters, the latter is more useful in preparing color descriptions and in suggesting comparative and grosser differences which may be checked with higher magnifications.

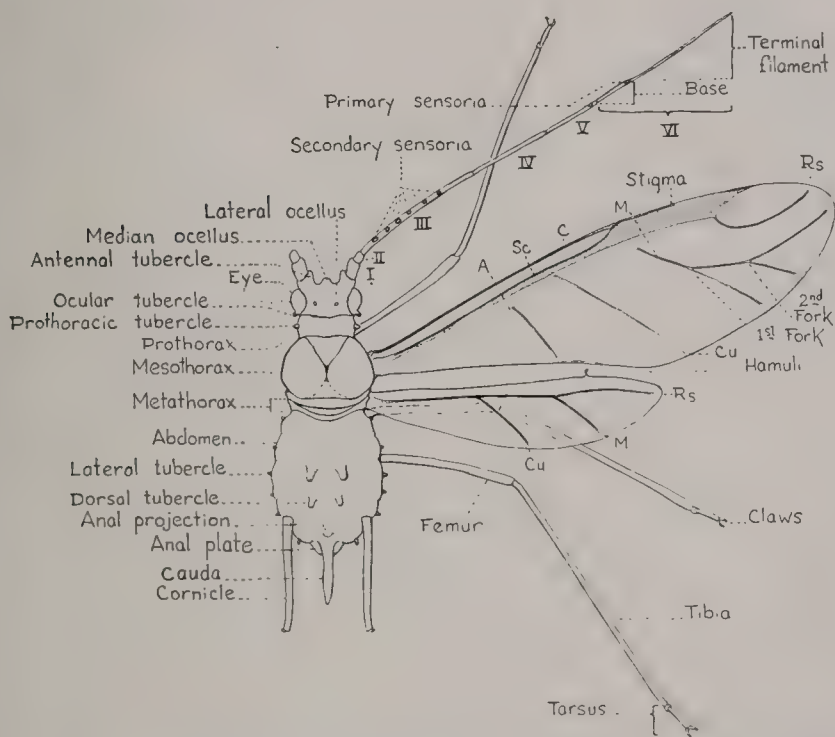


Fig. 2. Outline drawing of an imaginary plant louse, labeled to show anatomical structures used in describing and keying the various species.

In the fore wings of some aphids there is a kind of accessory thickening resembling a vein which runs somewhat parallel to the longitudinal radial vein. Since this structure has not been named in any of the previous works consulted and since it is often worthy of note in preparing descriptions, we have proposed for it the term of *accessory radial thickening*.

LIFE HISTORIES

Aphids have so many and varied ways of existence that no one generalized account can cover all of their interesting and often complicated life histories. Information about the life history of a species all too often begins and ends on a given host, leaving us in complete ignorance of the events transpiring between the time in the spring or early summer when the species leaves the host upon which it over-winters and the time when it returns to the same host again in the fall after a summer's sojourn upon some unknown host. Thus in the past, and even now perhaps, it has happened that a species of plant louse was known by one name when taken on its winter (primary) host and by another name when taken on its summer (secondary) host. This has been particularly true of those migratory species in which structural differences exist between the various forms of the same species, and it

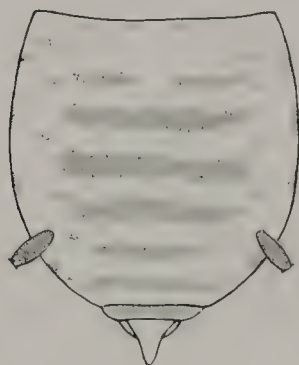


Fig. 3. (Left) Dorsal view of abdomen of the cabbage aphid, *Brevicoryne brassicae* (Linnaeus), showing pattern of dark markings.

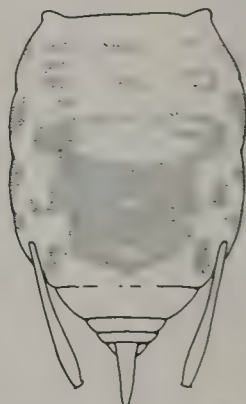


Fig. 4. (Right) Dorsal view of abdomen of *Capitorus gillettei* Theobald, showing pattern of dark markings.

is especially in such cases as these that biological studies are indispensable to a thorough and accurate picture of the relationships or classification of these insects. Dr. Edith M. Patch (1920) has admirably stated the difficulty: "To attempt to epitomize the life cycle of the aphid is like trying to draw an orderly sketch of Chaos. But after all, the confusion may be more seeming than real and certain rules, beset though they may be with exceptions, govern the life of even the aphid."

An aphid's behavior is governed very largely by its food preferences. A species that passes its entire life history on one host is said to be monophagous. If, however, a species requires two or more kinds of food, it may change its diet in early summer by migrating from the host on which it over-winters to a new host, called the summer or

secondary host, and such a species is said to be polyphagous. Some aphids, such as *Myzus persicae* (Sulzer), are practically omnivorous in that they accept as a secondary host almost any plant which offers sufficient nourishment and succulence for their ever-increasing numbers. Strangely enough, this ability to live on many different secondary hosts does not carry over to the sexual forms, for at the approach of cold weather in temperate and northern climates such plant lice return to their specific primary hosts like so many tourists returning to their homes from vacations spent in foreign places.

Generalized Life Cycles

In Illinois most aphids under natural conditions spend the winter in the egg stage. As a rule, the primary host upon which the eggs are laid is a tree or shrub (Figs. 8 and 9), the woody twigs and branches of which offer a greater degree of permanence for the preservation of the eggs than the more fragile, pithy stems of annual and herbaceous plants, which are often broken off at the ground and carried away by various agencies. The eggs, which are small, ovoid, and usually black, are laid either upon the twigs near the dormant buds, or upon the bark of the limbs, or in some cases even on the trunk. The hatching of the eggs in spring is usually correlated with the opening of the buds of the host.

If the species is a leaf-feeding form, the newly hatched aphids, which are called stem mothers, wander about on the twigs and branches until they reach the opening buds. Once they find these, they settle down and begin to feed. This feeding continues for about two weeks (the exact time depending largely on the temperature and species), and during this period the young aphids find it necessary to molt or shed their skins four times in order to provide for their rapidly increasing size. At the end of the fourth molt these first aphids to appear become full grown.

The stem mother is almost invariably apterous (wingless) and gives birth to living young parthenogenetically (without fertilization, there being no males at this time of the year). The production of living young is known as viviparous reproduction. A stem mother normally lives for about thirty days and gives birth to numerous young during this time. These progeny, when they become mature, closely resemble the stem mother and also give birth to living young parthenogenetically.

The third and fourth generations may or may not be apterous. Usually, however, especially if the species is migratory (polyphagous), a large proportion of the aphids are winged (alate) and are called spring migrants. If the species is not migratory, continuous generations of agamic females, either alate or apterous, are produced until the appearance of the sexual forms. The time of appearance of the sexual forms varies in accordance with the seasonal adjustments of the various species, but usually they are produced in the fall of the year.

If the species is migratory, the spring migrants fly to the secondary host of the species and there establish themselves and their progeny for the summer. Usually a migrating species entirely deserts its primary host for the summer, but occasionally the spirit of the wanderlust fails to develop in all individuals, so that some of them remain upon the

primary host throughout the year. On the secondary host several generations of alate and apterous females are produced during the remaining portion of the summer, each generation passing through the various stages of nymphal life before becoming mature. Summer generations usually require less time to mature than the stem mothers, and some individuals may become adults on the sixth or seventh day

LIFE CYCLE OF A MIGRATORY APHID

SEASON	FORMS ON PRIMARY HOST	FORMS ON SECONDARY HOST
WINTER	Egg ↓	None
EARLY SPRING	Stem Mother Apterous viviparous females ↓	None
LATE SPRING	Alate viviparous females ↓	Spring Migrants
SUMMER	A few strays ↓	Alate and apterous viviparous females ↓
EARLY FALL	Fall Migrants	Alate viviparous females sometimes alate males ↓
LATE FALL	Sexual forms: males and oviparous females ↓	Sometimes a few strays
WINTER	Egg	None

Fig. 5. Chart showing main sequence of events in the life cycle of a migratory aphid.

after birth. Each of them may produce from 60 to 100 progeny before dying at an age of 20 to 30 days. In the fall of the year alate females known as fall migrants, and occasionally alate males, are produced on the summer host. These alate females return to the primary host and there give birth to oviparous females (egg-laying females) and males in case the latter are not produced on the secondary host. The oviparous females, after mating, lay fertilized eggs as described above, and in this stage the species usually over-winter.

The short time that it takes these insects to mature, associated with their tremendous reproductive capacity (there may be ten or more generations a year even out of doors in temperate climates) led Huxley to calculate that the progeny of a single stem mother would in the fall of the year equal in weight the total weight of the population of China. This, fortunately, is purely hypothetical and never happens because enormous numbers of aphids are destroyed by other insects dependent upon them for food, by unfavorable weather conditions, and by many other means.

The cabbage aphid, *Brevicoryne brassicae* (Linn.), may be cited as a good example of a common and economic species with a rather generalized or orthodox life history. In Illinois this plant louse passes its entire life history, that is, from stem mothers in spring to sexual forms and eggs in autumn, on cabbage or related plants. There is no true or rhythmic migration from, or desertion of, the spring food plant, but simply a dispersion of individuals from time to time to other cruciferous plants.

Many other aphids, such as the various species of *Cinara* that feed on pine and certain species inhabiting oaks and birches, do not migrate from their primary food plants to secondary ones, but spend the entire life cycle upon a single host or at least upon very closely allied hosts. The alate forms of these monophagous aphids serve only to distribute the species, and not to satisfy a desire for a change in diet as do those of polyphagous species. Certain species, such as *Myzus persicae* Gillette and Palmer, living on columbine, and *Aphis rociadae* Cockerell, living on larkspur, find their hosts becoming unsuited for them very early in the summer, but instead of developing a migratory habit to more suitable hosts they meet this adversity by producing sexual forms, and laying eggs, at an early date.

A step further, but still a more or less generalized life cycle, is presented by the rusty plum aphid, *Hysteroneura setariae* (Thomas), shown in Fig. 30. This plant louse, which over-winters upon plum, migrates in early summer to various grasses upon which it spends the remainder of the summer. In fall certain alate viviparous females, the fall migrants, again return to plum in order that the life cycle may be completed on the primary host. Other examples of species with secondary hosts but still with more or less generalized life histories are: *Rhopalosiphum prunifoliae* (Fitch), which migrates between apple and cereal crops (Fig. 31); *Hyalopterus pruni* (Geoffroy), which migrates between plum and certain grasses; and *Aphis illinoisensis* Shimer, which migrates between viburnums and grape (Fig. 22).

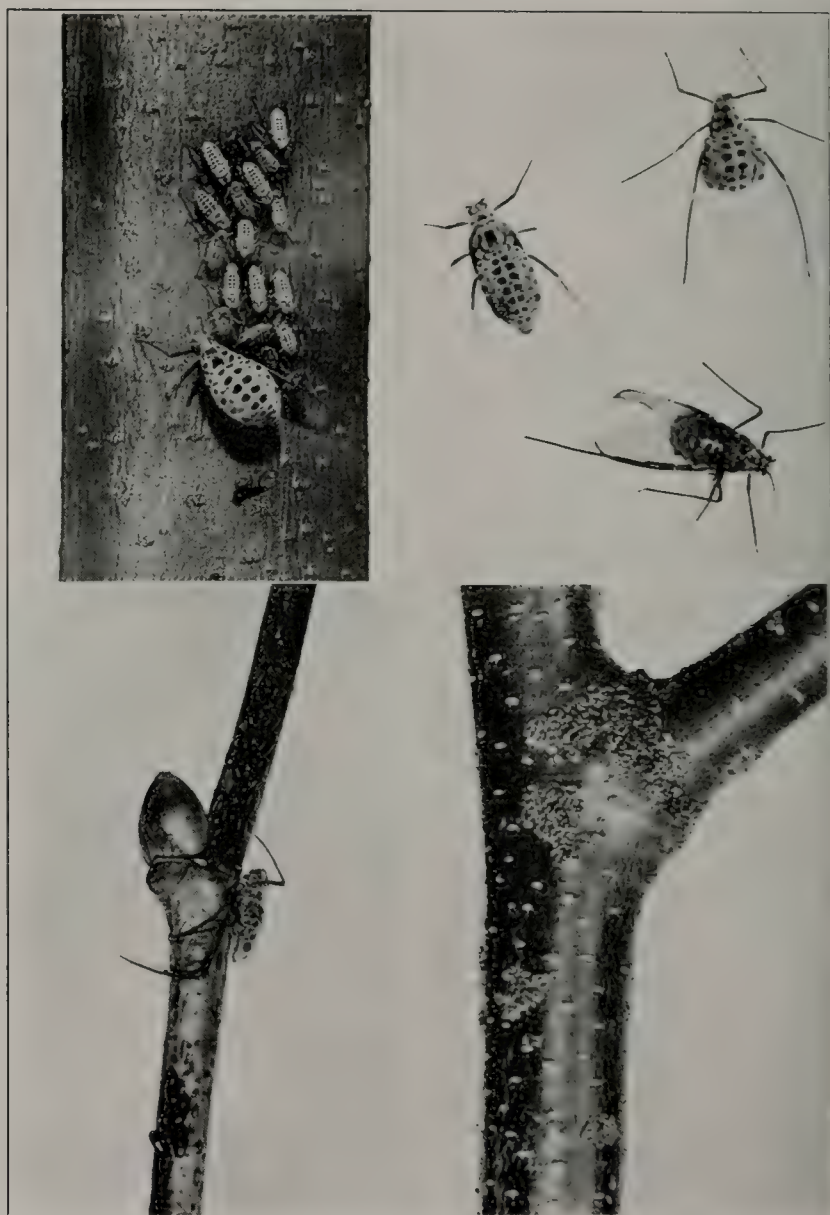


Fig. 6. (Upper left) Apterous viviparous female and young nymphs of *Longistigma caryae* (Harris) on the sycamore, *Platanus occidentalis*; Urbana, Oct. 14, 1929.

Fig. 7. (Upper right) Alate and apterous viviparous females and pupa of *Longistigma caryae* (Harris); Urbana, Oct. 9, 1929.

Fig. 8. (Lower left) Oviparous female and eggs of *Longistigma caryae* (Harris) on the basswood (*Tilia Americana*); Urbana, Oct. 15, 1929.

Fig. 9. (Lower right) Egg masses of *Calaphis betulaecolens* (Fitch) on low branches of the canoe birch (*Betula alba* var. *papyrifera*); Urbana, Oct. 15, 1929.

Specialized Life Cycles

Many plant lice have gone so far, in the development of generations living under difficult conditions, that the forms frequenting the secondary host have changed structurally and are markedly different from those produced on the primary host. For example, most of the plant lice producing true galls on the primary host plant (Figs. 40, 41, 47, 49) have very complicated life histories. Some of the common species producing galls in spring and early summer on poplars (*Pemphigus populi-transversus* Riley and *P. populicaulis* Fitch) migrate to the roots of various grasses for at least part of the summer. The alate females which return to the poplars in late fall or early spring are called sexuparae and give birth to odd-appearing sexual forms.

Very complicated life histories are exhibited also by several species in Illinois which migrate between very distantly related plants. Among these may be named *Hamamelistes spinosus* Shimer, *Hormaphis hamamelidis* (Fitch), and *Prociphilus tessellata* (Fitch), which is one of the few aphids known to hibernate in temperate climates as nyctaphs.

Hamamelistes spinosus Shimer hibernates on white birch in the form of greatly modified individuals (Fig. 40), resembling coccids more than they do aphids; descendants of these hibernating coccid-like aphids fly in early spring to witch-hazel, upon which the sexual forms are produced. The eggs are soon laid but do not hatch until May or June of the following year. Descendants of the individuals hatching from the over-wintering eggs on witch-hazel migrate to birch, where other generations soon modify themselves into the coccid-like individuals mentioned above. Thus this species spends the winter on both of its hosts but in two different ways.

Prociphilus tessellata (Fitch) migrates between maples and alders. The sexual forms are produced on maples by migrants leaving the alders in fall. The over-wintering eggs produce stem mothers in spring, which produce generations (*acrifolii* Riley) destined to return in summer to alders. Although interrupted on its probable original host, the maple, the life cycle may continue on alders until the colony is destroyed by accident, disease, death of the host plant, or attack by enemies.

In warm climates, and under greenhouse conditions in colder climates, the life histories of aphids may be so modified that they may go on indefinitely reproducing viviparously for years. Certain subterranean species, too, like *Geocica squamosa* Hart, have become modified to an entirely subterranean type of life, so that the aerial forms have dropped out of existence, at least in certain geographical areas.

DISTRIBUTION

In many ways the plant lice offer much material for the student of zoogeographical distribution in temperate climates. They are large enough as a family to give us a group of closely related organisms surpassing in the number of species within the confines of our state such familiar, larger, and varied taxonomic groups as the trees, fishes, birds, or mammals. Two easily recognized factors, together with many others less tangible and apparent, have conspired to make the plant louse

fauna of Illinois an extensive one; namely, the fact that aphids as a group are preeminently at home in temperate climates and that the flora of Illinois upon which they directly depend for sustenance is a large and varied one, comprising components characteristic of the cypress swamps of the south, the tamarack swamps of the north, the prairie, the deciduous forests, and local biota of diverse composition.

It seems clear at the present time in Illinois that the zoogeographical distribution of our plant louse fauna is governed primarily by the distribution of their plant hosts, all other factors being secondary and

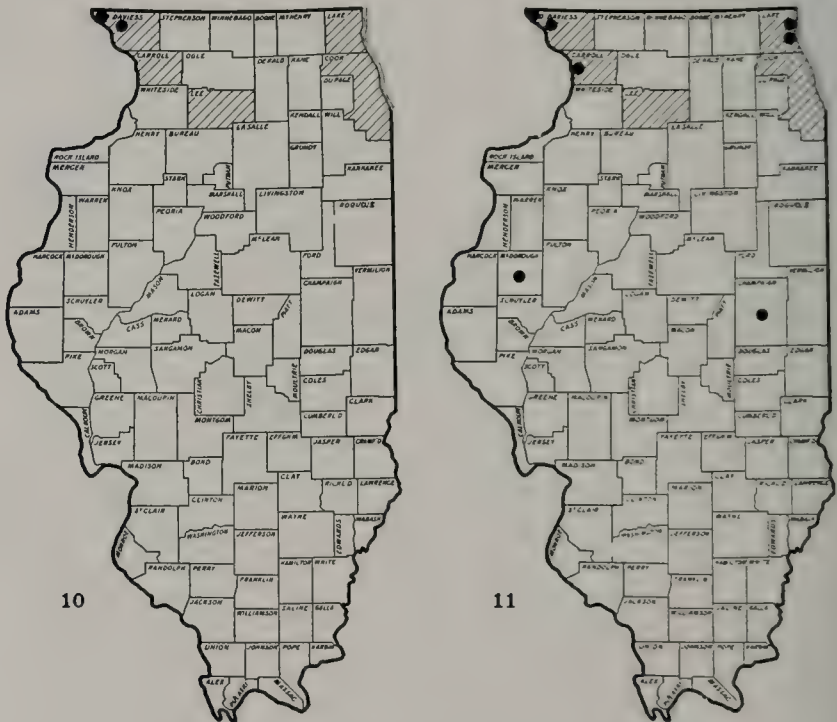


Fig. 10. (Left) Distribution of *Euceraphis betulae* (Koch) and its host, the canoe birch, *Betula alba* var. *papyrifera*.

Fig. 11. (Right) Distribution of *Calaphis betulaecolens* (Fitch) and its host, the canoe birch, *Betula alba* var. *papyrifera*. Dots in the central portion of the state indicate occurrence on planted trees.

often of a fluctuating character. This generalization, obvious to the student of the aphids, is readily illustrated by the maps in our file showing the known distribution in our state of all species of aphids known to occur in Illinois with the distribution of their host plants. A few of these maps are reproduced here (Figs. 10-17). On each map the dots indicate localities in which the species has been collected and the cross-hatching indicates the counties in which its host has been recorded as native.

Of course, the physiological nature of the various species plays an important part in their distribution and abundance. It must not be forgotten, however, that the plant lice have developed after the plants and have had to fit into a floral pattern probably previously and certainly independently determined. The tamarack of our northern bogs would continue to live, conditions being favorable for its existence, without its aphid, *Cinara laricis* (Hartig) (Fig. 12), but since the aphid has become restricted to this one host it could not survive without the tamarack. Where the physiological make-up of a species of aphid in



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13

Fig. 12. (Left) Distribution of *Cinara laricis* (Hartig) and its host, the tamarack, *Larix laricina*.

Fig. 13. (Right) Distribution of *Phyllaphis fagi* (L.) and its host, the beech, *Fagus grandifolia*.

Illinois has tightly tied it up with a single species of host plant, or several very closely related host plants, that aphid obviously exists only where its host is present. Many examples of the primary factor of host distribution governing the distribution of monophagous plant lice in Illinois could be cited (Figs. 10-13).

There is ample evidence to show that the physiological constitution of an aphid has limits, secondary to the presence of host plant or host plants, which regulate the outlines of a full and complete picture of

the distribution of any given species of aphid over North America or the world as a whole. The aphid, *Eucerraphis betulae* (Koch), naturally occurs in Illinois only where the canoe or paper birch (Fig.10) is native, but its physiological construction is such that it can live on specimen trees in various parts of the state. It would be a mistake to think of the present natural distribution of this plant louse as we find it in Illinois as being strictly in conformity with certain optima of temperatures, humidities, and other meteorological factors. The maximum extent of its distribution certainly can be limited or influenced by such factors.



Fig. 14. (Left) Distribution of *Aphis pomi* DeGeer and one of its many hosts, the cultivated apple, *Pyrus Malus*.

Fig. 15. (Right) Distribution of *Macrosiphum pisi* (Kaltenbach) and one of its hosts, the red clover, *Trifolium pratense*.

but these limits cannot be determined solely by a glance at a distribution map of this aphid as we see it in Illinois where the natural range of its host is alone sufficient to be the decisive and the limiting factor.

There are, no doubt, species of plant lice in Illinois which, in spite of having a suitable host or combination of hosts in all parts of the state, exhibit a tendency of "southernness" or "northernness" of distribution because of limiting factors of a physiological nature. Our survey of the plant lice fauna, however, has not been thorough enough.

or quantitative enough, in all parts of the state, to bring such cases into bold relief. *Aphis feminea* Hottes is a conspicuous reddish brown and black species with a gregarious habit known only to occur on the wild black cherry so common in all parts of Illinois. We have taken it only once, in spite of diligent searching in apparently similar situations in many places throughout the state. (Fig. 17). Why have we not found it elsewhere? Perhaps it is a migratory form and the host combination essential for its existence rarely occurs; perhaps it is a recent or accidental introduction (only recorded in literature from

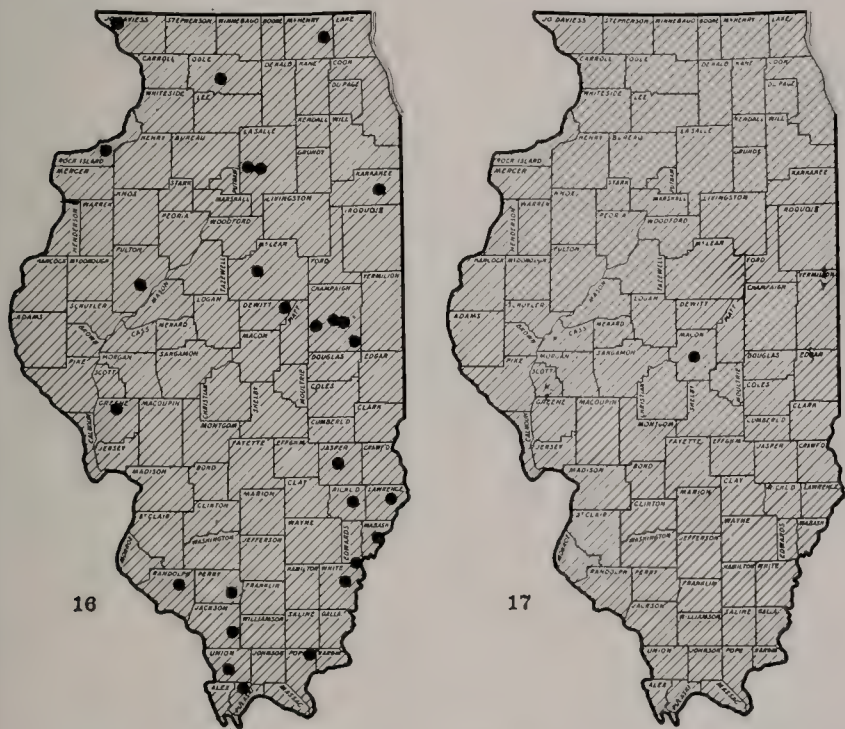


Fig. 16. (Left) Distribution of *Macrosiphum granarium* (Kirby) and its usual host, oats, *Avena sativa*.

Fig. 17. (Right) Distribution of *Aphis feminea* Hottes and its host, the wild black cherry, *Prunus serotina*.

Maine); perhaps it is such a rarity where it does occur that it is seldom seen; but perhaps the limiting factor is a physiological make-up which demands a certain combination of environmental factors which its host does not require. *Phyllaphis fagi* (Linnaeus) and *Prociphilus imbricator* (Fitch), both found as yet only on beech, are at present known only in Illinois from certain localities in the extreme southern part of the state (Fig. 13) where beech trees are closely associated and numerous. We have looked for these species in other parts of

Illinois (Fig. 13) where beech is native, but scarce, without finding them. This may be due to the physiological nature of these aphid species which ties up their distribution with large stands of beech—a tree of the climax forest in Illinois. The absence of records of *P. fagi* and *P. imbricator* from certain places in Illinois, however, may be due to the lack of a suitable combination of hosts, if these species have alternate hosts, or to error in collecting. Even though definite Illinois species of aphids are difficult to select as exhibiting examples of distribution limited by the physiological constitution of the aphid, there is ample evidence from a study of the world-wide distribution of plant lice, and from experimental studies, to show conclusively that physiological constitution is an important factor, however secondary, in a small geographical area as Illinois, it may now be to a present association with host due to close evolutionary development of aphids with certain plants.

If one wishes to study the influences of temperature, relative humidity, and other factors as determinants in the distribution of Illinois species of plant lice, the omnivorous species afford the best prospects. As stated elsewhere, however, our Illinois field work was not thorough or quantitative enough to bring into bold relief examples illustrating this correlation. Illinois appears to us to be located in the center of the aphid current—a group of insects ideally adjusted to temperate climates.

CYRUS THOMAS COLLECTION

Davis (1913), in an earlier article of the present bulletin series, reported upon the Aphididae in the Cyrus Thomas collection, belonging to the Survey, which at that time could be associated with data or recognized as types. In that article the types, or probable types, of twelve species were reported as recovered and notes given regarding their systematic status, insofar as their identification was possible by labels or bits of information associated with certain vials or slides.

At the time of the writing of the paper by Davis, it was not possible to report upon much of the original Thomas material because many vials or slides were associated only with a number, the key to which had been lost. In 1926, a letter written to Professor S. A. Forbes in April 21, 1884, by Mrs. Nettie Beattie (Miss Nettie Middleton), at one time an assistant of Thomas, was found by Frison in an old letter file while searching for data regarding the dates of publication of certain reports of the state entomologists of Illinois. This letter contained a list of numbers from 1 to 78 and gave data to be associated with certain numbered vials or slides of specimens in the Thomas collection. The fortunate finding of this letter has resulted in the recovery of the types of thirteen more of the Thomas species described in 1878-1879 and the confirmation of the true "type" status of almost all material previously reported as being "probable" types by Davis. It so happens that the real Thomas types previously found by Davis with one exception, were species described in the 1879 article and the types recently identified were described in the 1878 paper. The types of all but four of the eighteen species described as new in 1878 have now been found.

Notes concerning these recently recovered types are scattered throughout the text under the specific names of the species to which the various types must be referred. The finding of these types ends definitely the uncertainty in regard to the specific status of some of the species originally described by Thomas. For their better preservation, all of the specimens in the Thomas collection of plant lice in the Survey collection have been mounted on slides. For the convenience of workers located elsewhere, the following list of the species described by Thomas is given together with notes concerning their present placement, the slide numbers assigned to them, etc.

DESIGNATION OF TYPES

In the description of new species of aphids the authors have departed from past customs in definitely selecting, wherever possible, a slide mount of an alate viviparous female as the *holotype* and a complement of mounts designated as *allotypes*, *morphotypes*, and *paratypes*. The term *allotype* is applied to a slide mount of a specimen of the opposite sex from the type, either when included in the paratypic series of a new species or when described for the first time in this paper. It happens that all allotypes in this paper are males. The oviparous and apterous viviparous females have been designated as morphotypes, whether included in the paratypic series of a new species or described for the first time in this paper, except where a new species has been described from the apterous viviparous female on account of the lack of alate specimens. The employment of this terminology is in line with present procedure in other groups of insects, and it leads indirectly to the better preservation of the specimens upon which first descriptions are based—a boon to future students and revisional writers. It also directs attention to the descriptions of forms which should and will receive more study in the future.

Oftentimes but one specimen has been mounted on a slide with the end in view of making such a mount a holotypic, allotypic, or morphotypic slide. Where this was not possible, from lack of recognition of forms as new to science in proper time, certain specimens have been indicated by the well-known method of "ringing" them on the slide. Wherever possible, the sexual forms have been described from mating pairs or from sexual forms taken on the same host and at the same time and place.

In a few cases *lectotypic* slides have been designated to stand as holotypes from a series of cotypic slides. This has been done to help eliminate nomenclatorial problems resulting from the mixing of two species in a series of cotypic slides. Such selections are clearly noted in the text under the names of the species concerned. Certain slides in the Survey collection previously have been designated as lectotypes, or their typic status reported upon, by Frison (1927).

TABULATION OF SPECIES DESCRIBED BY CYRUS THOMAS AND RECORDS OF TYPES

<i>Name used by Thomas</i>	<i>Present assignment</i>	<i>Reported by Davis</i>	<i>Recently Recovered</i>	<i>Slide Numbers</i>
<i>Aphis cephalanthi</i>	<i>Aphis cephalanthi</i>.....	.....	.....	.....
<i>Aphis diospyri</i>	<i>Aphis cephalanthi</i>.....	.....	Yes	8778
<i>Aphis impatiensis</i>.....	.....	.....	.....	.....
<i>Aphis middletonii</i>.....	.....	.....	.....	.....
<i>Aphis symphoricarpi</i>	<i>Thargelia symphoricarpi</i>.....	.....	Yes	8776, 2792
<i>Aphis vernoniae</i>	<i>Aphis vernoniae</i>.....	.....	Yes	7704-7707
<i>Callipterus quercifolii</i>.....	.....	.....	.....	7658
<i>Callipterus ulmicola</i>	<i>Chaitophorus quercicola</i>	Yes	.....	7166
<i>Chaitophorus negundinis</i>	<i>Tuberculatus ulmifolii</i>	Yes	.....	2775
<i>Chaitophorus populicola</i>	<i>Periphyllus negundinus</i>.....	.....	.....	8177
<i>Megoura solani</i>	<i>Periphyllus populicola</i>.....	.....	Yes	2772
<i>Myzocallis hypelci</i> (= <i>hyperici</i>).....	<i>Amphorophora solani</i>	Yes	.....	2797
<i>Pemphigus fraxinifolii</i>	<i>Hyalopterus hyperici</i>.....	.....	Yes	2762, 7167
<i>Pemphigus rubi</i>	<i>Pemphigus fraxinifolii</i>	Yes	.....	.....
<i>Phorodon scrophulariae</i>	{ Probably { <i>Pemphigus populi-transversus</i>	Yes	.....	2767, 2768
<i>Rhizobius eleusini</i>	<i>Myzus scrophulariae</i>.....	.....	Yes	2798
<i>Rhizobius poae</i>	<i>Anoea querci</i>.....	.....	Yes	8777
<i>Rhopalosiphum tulipae</i>.....	.....	.....	.....	.....
<i>Schizoneura panicola</i>	<i>Myzus persicae</i>	Yes	.....	7657
<i>Schizoneura pinicola</i>	<i>Anoea querci</i>	Yes	.....	2770
<i>Siphia rubifolii</i>	<i>Mindarus abietinus</i>	Yes	.....	2774
<i>Siphonophora acerifoliae</i>	<i>Cerosiphia rubifolii</i>.....	.....	.....	.....
<i>Siphonophora ambrosiae</i>	<i>Drepanaphis acerifoliae</i>	Yes	.....	7168, 7169
<i>Siphonophora coreopsidis</i>	<i>Macrosiphum ambrosiae</i>.....	.....	Yes	8179-8181
<i>Siphonophora cucurbitae</i>	<i>Aphis coreopsidis</i>.....	.....	Yes	7716
<i>Siphonophora erigeronensis</i>.....	.....	.....	.....	.....
<i>Siphonophora euphorbiae</i>	<i>Macrosiphum erigeronensis</i>.....	.....	.....	.....
<i>Siphonophora euphorbiae</i>	<i>Macrosiphum gel.</i>.....	.....	Yes	8771
<i>Siphonophora gerardiae</i>	<i>Macrosiphum gel.</i>.....	.....	Yes	8772, 8773
	<i>Aphis rumicis</i> var. <i>gerardiae</i>.....	.....	.....	.....

<i>Name used by Thomas</i>	<i>Present assignment</i>	<i>Reported by Davis</i>	<i>Recently Recovered</i>	<i>Slide Numbers</i>
<i>Siphonophora heucherae</i>	<i>Myzus heucherae</i>	Yes	.....	{ 3174, 3175 } 7163-7165
<i>Siphonophora salicicola</i>	<i>Aphis saliceti</i>.....	.....	Yes	8178
<i>Siphonophora setariae</i>	<i>Hysteroneura setariae</i>.....	.....	Yes	7714, 7715
<i>Siphonophora verbenae</i>.....	.....	.....	.....	.....
<i>Siphonophora viticola</i>	<i>Aphis illinoensis</i>.....	.....	Yes	7698, 7699
<i>Tychea erigeronensis</i>	<i>Prociphilus erigeronensis</i>	Yes	.....	2769
<i>Tychea panicl.</i>.....	.....	.....	.....	.....

COLLECTION AND PRESERVATION OF MATERIAL

Aphid material in the field was collected by brushing the plant lice off the host into a metal-capped vial partly filled with tissue paper to absorb moisture or by breaking off a small portion of the infested plant and placing it, together with the plant lice, in a similar vial. Specimens collected in this manner were usually mounted the same day or the next day, by the methods mentioned in following paragraphs. Almost all of the material collected on field trips was mounted on slides, and to do this it was necessary to carry a rather complete equipment with us in the field. The slide mounts thus made from live material, however, more than justified the carrying of the extra equipment and the spending of many hours at night making slides. It was found that three persons constituted an ideal aphid-collecting party, two doing the field work during the day while one made slide preparations, and all assisting with slide mounts at night. Without automobile facilities for rapidly transferring the field party and equipment, such intensive work on a group of insects within such a short time would not be possible.

Since plant lice are small, soft-bodied, delicate insects, they must be preserved in fluids in vials or mounted on slides. From the standpoint of maintaining a reference or study collection, and the ordinary determination of specimens, we are very partial to the preservation of all material on slide mounts. For certain morphological studies, however, plant lice may be best preserved in fluids, and an 80% alcohol solution has proved very satisfactory.

Aphids preserved in alcohol can be mounted very easily in "Euparal," a prepared mounting fluid. They are simply taken from the alcohol and mounted directly in "Euparal" on the slide. They clear in a day or two, depending upon their size, and the medium forms a yellowish, hard mount. This method of dealing with alcoholic material, especially when it is of considerable age, is more satisfactory than that of running the material through alcohol and xylol and mounting in balsam; for the treatment with the higher concentrations of alcohol, and especially with xylol, makes the legs and antennae of aphids so brittle that they break off when the cover glass is put over the insects on the slide.

For killing aphids and mounting them immediately, we have used the following method, which, besides being relatively fast, usually gives very good results. With a camel's hair brush the aphids are removed from their host to a beaker (50 cc), where they are killed by pouring hot water over them. The water is immediately drained off and replaced with hot 95% alcohol. The contents of the beaker are then poured into a Syracuse watch glass, in which the aphids can be handled more easily. Large or shrivelled aphids are punctured with a needle, to allow the infiltration of xylol and consequent clearing. Small, thin-skinned forms do not require puncturing. After standing until cool, the alcohol is drained from the aphids and xylol carefully poured over them. They are left in this until clear and then mounted in Damar balsam on 3"x1" glass slides, using as thin a cover-glass as can be handled with efficiency. This method of mounting gives particularly beautiful results with some of the light and highly-colored *Macrosiphea*.

preserving in a measure the natural colors which are enhanced by transparency.

Certain species of aphids are hard to clear, particularly some of the large, apterous, root-feeding forms. If they do not clear after being in xylol for fifteen or twenty minutes, drain off the xylol and add a little alcohol; then draw off this alcohol after a minute or two, and add a second lot of xylol. This will usually hasten the clearing, but the entire procedure may have to be repeated several times in order to give the desired transparency. This process, however, makes the aphids very brittle and should be avoided whenever possible. We believe that Damar balsam is very much superior to Canada balsam as a mounting medium, because it forms an almost unstained medium and hardens a little faster when the slides are first prepared.

Full data concerning host plant, time of year, etc., should be kept associated with all collections of plant lice, regardless of the method used in their preservation. Since the natural colors of aphids are liable to be lost by any method of preservation, it is highly desirable to keep detailed color notes made from living specimens.

APPLIED CONTROL*

Being soft-bodied, sucking insects, aphids are best controlled by the use of contact insecticides. The susceptibility to insecticides, however, varies greatly among different species of aphids. Many species can be killed by very mild preparations which will not affect other species. The most common materials now in use for combating aphids are soap solutions, oils, nicotine, pyrethrum, and derris. Only the more susceptible species may be killed with the soap solutions. These insecticides are applied in the form of dusts or sprays. In many cases spraying is more efficient and reliable than dusting. Because of their tremendous powers of reproduction, it is generally considered that any control measures used against aphids must kill at least 98% of them in order to be commercially successful.

The insecticides must be applied in such a way as to come into actual contact with the bodies of the aphids. Spraying or dusting the tops of leaves where aphids are working on the underside of the leaf is of no value. The problem of satisfactory control is made more difficult by the fact that many species of aphids cause curling of the foliage on which they are feeding. It is usually necessary to apply the dust or spray with considerable force in order to reach the aphids in curled foliage.

Dusts

Of the dust insecticides, nicotine is by far the most effective. Where the fumes from nicotine dust can be partly confined around the bodies of the aphids, a very good kill may be obtained. Nicotine dusts may be purchased ready to use or may be mixed at home by several methods. The advantages of home mixing, or "rolling your own," are a saving of nearly one-half of the cost of the prepared dust, a better guarantee of fresh material which is of a higher killing power,

* This section was prepared by W. P. Flint.

and immediate availability when needed without waiting for shipment from a distance. Good homemade nicotine dust can be prepared as follows:

For Mixing Small Quantities of Dust.—Place 6 pounds of hydrated lime, talc, dusting sulphur, or other dust to be used as a diluent, in a can, bucket, or small keg, which has a tight-fitting lid. Pour 5 ounces of 40% nicotine sulphate, or 40% free nicotine, over the dust in the container; add 10 to 15 small stones about the size of walnuts, close the lid tightly, and roll the container back and forth for ten minutes. Do not roll rapidly, as the dust will mix better at about 30 to 40 revolutions per minute. After the mixing has been completed and the stones removed, the dust should be allowed to stand for 24 hours in a closed container before being used. If it is to be stored, it should be placed in a tight container and kept in a dry, cool place.

For Mixing Larger Quantities of Dust.—Use a 50-gallon tight barrel, or large keg. Cut a door in the side of the barrel to make a 6"x8" opening. Attach the door so that it will fit tightly into the barrel, padding the edge with cloth or felt to prevent leakage of the dust, and fastening it on the outside so that it will be held tightly in place. Place the hydrated lime, dusting sulphur, or other dust in this container. Pour the desired amount of nicotine over the dust (see table of amounts), and add about 50 small stones from the size of a walnut to that of an egg. Close the door and roll the barrel back and forth over the ground for ten minutes. Remove the dust by pouring through a wire screen with meshes of $\frac{1}{4}$ or $\frac{1}{2}$ inch to catch the stones. Store in tight containers.

TABLE SHOWING AMOUNTS OF MATERIALS TO BE USED IN MIXING
NICOTINE DUSTS

Percentage desired	Pounds of 40% free nicotine or nicotine sulphate to be used	Pounds of hydrated lime or other dust to be used
1	1 $\frac{1}{4}$	49
2	2 $\frac{1}{2}$	48
3	3 $\frac{1}{4}$	47
4	5	45

As the materials for making the dust will keep much better than the prepared dust, it is advisable to mix only what is needed at one time rather than larger quantities to be stored for the season. The nicotine sulphate has a more lasting effect than the free nicotine, but does not give quite as high a kill of resistant insects for the same percentage of nicotine in the mixture.

Take care to avoid breathing the fumes when mixing nicotine dust. Especially avoid holding the head too close to the mixer when pouring out the dust, as the nicotine will be strong enough to cause headache or nausea if a sufficient quantity is breathed.

Sprays

A spray that is very effective against aphids can be made at home very easily and quickly by mixing one part of 40% nicotine sulphate with eight-hundred parts of water and four parts of "Penetrol," which is a commercial product recently developed as an activator for nicotine.

The "Penetrol" increases the killing power of the nicotine so that the spray can be relied upon to be 100% effective against all classes of plant lice if applied to their bodies.

A spray of nearly as high killing power may be made by using soap instead of Penetrol. In this case soft water should be used. The following formula will make an excellent aphid spray:

Nicotine sulphate	1 part
Water	800 parts
Soap	1/2 ounce to 1 gallon of water

A number of commercial preparations for the control of aphids are now on the market. Where these are used, they must be applied at strengths and under conditions recommended by the manufacturers.

NATURAL CONTROL AND INTERRELATIONS

Plant lice are often so completely held in check by natural control factors, such as parasitic and predaceous insects, fungus diseases, and unfavorable weather conditions, that applied or artificial control is not necessary. The writings on this subject would fill several volumes and it would be inadvisable in this paper to attempt to give a detailed account of them. The reader is referred, rather, to the numerous publications listed in the bibliography, many of which contain much information about this phase of the subject.

The chief insect enemies are the common lady bird beetles (Coccinellidae), the syrphid flies (Syrphidae), the lace wing flies (Chrysopidae), and certain minute wasp-like insects (Braconidae and Chalcididae). The first three of these groups of insects are predaceous, and only the last group are internal parasites. The chief fungus enemies belong mainly to the genus *Empusa*. Many birds, also, eat plant lice and their eggs and thus aid in their control.

The interrelations between ants and aphids have attracted the attention of scientists and others from the earliest to the present times, and again volumes have been written upon the subject. It suffices here simply to state that ants frequently care for aphids in return for a secretion commonly known as "honey-dew." In some cases this care on the part of the ants for the aphids is of a temporary nature, but in other cases the interrelationship has proceeded so far that certain species of plant lice are said to be absolutely dependent upon ants. The corn root aphid (*Aphis maidi-radicis* Forbes) is a good example of a plant louse relying to a great extent upon ants. Forbes (1884) has shown that the eggs of this aphid are cared for by the ants during the winter. For a complete review of the interrelations between ants and aphids the reader is referred to a recent and excellent paper by Jones (1929).

PART II

FAMILY APHIIDAE

By the incorporation of information regarding the biology and phylogeny of aphids, along with certain structural characters, it is possible by the use of a few couplets to key the aphids into two, three, or four subfamilies, depending upon the classification adopted. In preparing a purely artificial key for the determination of the aphids for the use of persons not having esoteric information, it is impossible to key the subfamilies without resorting to the use of numerous couplets or expanding a few couplets to include numerous exceptions. In line with our policy of making keys to begin with an unknown and end with a known, without the injection of information concerning phylogeny or biology, we have been forced to use numerous couplets. This is rather indicative of the fact that the aphids can not be divided easily, concisely, or sharply into two, three, or four subfamilies comparable to the subfamilies of some other families of insects. It indicates, also, that the present classification has many points in it which are purely arbitrary and hence may be changed in the future.

It must also be kept in mind that this paper is not a revisional study in its broadest sense, and that the keys are prepared solely for the recognition of our Illinois fauna. Species not included in this paper may or may not key out correctly.

KEY TO SUBFAMILIES

(Based on alate viviparous females)

1. Antennae with pronounced annular or band-like sensoria almost completely encircling segment (Fig. 224).....2
- Antennae with circular (Fig. 283), transverse (Fig. 226) or elongate-oval (Fig. 227) sensoria, not almost completely encircling segment.....3
2. Anal plate indented, cauda knobbed (Fig. 222), both distinct; antennae of alate forms either three- or five-segmented, aleurodi-form or coccidiform generations (Fig. 332) developed, aerial forms, confined to birches and witch-hazel.....*Hormaphidinae* (*Hormaphis*) p. 375
- Anal plate and cauda rounded, indistinct (Fig. 221); antennae of alate forms six-segmented [except *Melaphis minutus* Baker which is five-segmented—not known from Illinois]; aleurodi-form or coccidiform generations not developed; aerial generations on various plants, especially elms and poplars, and subterranean generations on roots of various plants.....*Eriosomatinae* (in part) p. 345
3. Radial vein of fore wing arising near base of stigma or where stigmal shading begins (Fig. 51).....*Mindarinae* (*Mindarus*) p. 374
- Radial vein of fore wing arising from body of stigma (Fig. 56) or at its apex (Fig. 67), always beyond base of stigma or where stigmal shading begins.....4

4. Terminal filament of sixth antennal segment longer than basal portion5
- Terminal filament of sixth antennal segment not longer than basal portion6
5. Terminal filament with distinct sensoria.....
-*Eriosomatinae* (*Mordwilkoja*, fundatrigenia) p. 345
- Terminal filament without distinct sensoria.....
-*Aphiinae* (in great part) p. 149
6. Terminal filament a mere stub (Fig. 241), in length about equal to greatest width of segment.....7
- Terminal filament distinct (Fig. 266), at least twice as long as greatest width of segment.....*Aphiinae* (in part) p. 149
7. Costa of hind wing nearly straight, branches not originating at same point and more or less parallel (Fig. 87).....8
- Costa of hind wing curving upwards near point of articulation with branches originating at or about the same point, therefore forming a somewhat three-fingered fork (Fig. 94).....
-*Eriosomatinae* (in part) p. 345
8. Cornicles conspicuous, cone-like or on prominent elevations (Fig. 130).....*Aphiinae* (in part) p. 149
- Cornicles lacking, or indistinct and mere rings, not on prominent elevations (Fig. 159).....9
9. Antennae five-segmented.....*Eriosomatinae* (*Forda* and *Geocica*) p. 345
- Antennae six-segmented.....10
10. Fore wings with medial veins not branched (Fig. 64).....
-*Eriosomatinae* (*Prociphilus* and *Trifidaphis*) p. 345
- Fore wings with medial veins branched (Fig. 69).....11
11. Sensoria narrow, transverse, many encircling at least half of segment.....*Eriosomatinae* (*Georgiaphis*) p. 345
- Sensoria circular or transverse-oval.....
- ...*Aphiinae* (*Tamalia*, *Phyllaphis*, *Eulachnus* and *Stegophylla*) p. 149

SUBFAMILY APHIINAE

KEY TO SUPERTRIBES

1. Terminal filament of sixth antennal segment shorter than base of segment (Fig. 231).....2
- Terminal filament of sixth antennal segment equal to (Fig. 234), or longer than (Fig. 248), base of segment.....4
2. Stigma of fore wings linear, very long and narrow (Figs. 52, 59, 67); epicranial suture on head distinct (Fig. 75).....
-*Lachnea* (*Cinara*, *Eulachnus*, *Longistigma*, and *Tuberolachnus*) p. 150
- Stigma of fore wings short, usually more bulbous in shape (Figs. 54, 56, 62, 66); head without epicranial suture (Fig. 79).....3
3. Antennae with numerous, long, hair-like setae (Fig. 231).....
-*Lachnea* (*Anoecia*) p. 150
- Antennae without such hair-like setae, at most with a few, scattered short setae (Fig. 235).....*Callipterea* (in part) p. 242
4. Body or appendages (exclusive of tibiae and tarsi), or both, with numerous, long, hair-like setae (Figs. 230, 324), the setae never enlarged or modified at tip.....*Chaitophorea* (in part) p. 160
- Body and appendages (exclusive of tibiae and tarsi) without long, hair-like setae, either with a few short, scattered setae (Fig. 285), or with setae enlarged at the tip and modified (Figs. 316, 317, 318, 320).....5

5. Anal plate either distinctly indented (Fig. 220) or bilobed (Figs. 168, 219) except in *Euceraphis*; cauda knob-like (Figs. 178, 219), with a constriction near the middle, the apical portion circular or transverse-oval; cornicles, if apparent, trapezoidal (Fig. 155), never long and cylindrical; secondary sensoria often elongate-oval (Fig. 236).....**Callipterea** (in part) p. 242
- Anal plate always with apex rounded (Fig. 214), never indented; cauda clavate (Fig. 187) or tapering (Figs. 185, 199), never knob-like; cornicles, if apparent, usually cylindrical (Fig. 135), often long (Fig. 120) or swollen (Figs. 145, 148, 149, 160), never trapezoidal; secondary sensoria round (Figs. 268, 274, 293) never elongate oval.....6
6. Cornicles either absent or much shorter than hind tarsi exclusive of claws.....7
- Cornicles subequal to, or longer than, length of hind tarsi exclusive of claws.....8
7. Anal plate wide V-shaped (Fig. 209), cauda subequal to anal plate in length, rounded; third antennal segment very long, almost twice width of head across eyes.**Chaitophorea** (in part) p. 160
- Anal plate semi-circular (Fig. 210), cauda tapering to more or less of a point, usually much longer than anal plate; third antennal segment (except in *Brevicoryne*) subequal to width of head across eyes.....**Aphiea** (in part) p. 175
8. Cornicles absent or minute.....
-**Aphiea** (*Asiphonaphis* and *Brachycolus*) p. 175
- Cornicles present and conspicuous.....9
9. Hind wings with one oblique vein (cubitus) lacking (Fig. 89) or only partially developed, or with both oblique veins (cubitus and media) lacking (Fig. 96).....10
- Hind wings with both oblique veins (cubitus and media) present (Fig. 91)12
10. Radial sector of fore wing deeply curved downward and either uniting with media to form a closed cell beneath stigma (Fig. 74) or almost uniting with media (Figs. 58, 66).....
-**Macrosiphea** (*Idiopterus* and *Pentalonia*) p. 273
- Radial sector of fore wing not deeply curved downward, no closed cell beneath stigma (Figs. 56, 62).....11
11. Hind wings without oblique veins (cubitus and media) (Fig. 96)**Macrosiphea** (*Microparsus*) p. 273
- Hind wings with one oblique vein (cubitus) lacking or only partially developed...**Aphiea** (*Alphitoaphis* and *Hysteroneura*) p. 175
12. Media of fore wings normally branched once (Fig. 70).....**Aphiea** (*Toxoptera*) p. 175
- Media of fore wings normally branched twice (Fig. 62).....13
13. Inner margins of antennal sockets considerably produced anteriorly (Figs. 82, 86).....**Macrosiphea** (in part) p. 273
- Inner margins of antennal sockets not produced anteriorly or only very slightly so (Fig. 80).....**Aphiea** (in part) p. 175

SUPERTRIBE LACHNEA

KEY TO GENERA

1. Fore wings (Fig. 59) with dark suffusion of stigmal region extending as a distinct band beyond stigma to tip of wings..... **Longistigma** p. 157
- Fore wings (Figs. 60, 67) with stigmal suffusion not extending as a distinct band to tip of wings.....2

2. Radial sector (Fig. 68) of fore wings bowed, arising from body of stigma; not feeding on conifers.....3
- Radial sector (Figs. 60, 67) of fore wings straight, arising from lower distal angle of stigma; feeding on conifers.....4
3. Dark stigmal suffusion of fore wings bulbous in shape (Fig. 68); hind tibiae little if any longer than antennae; without large tubercle on dorsum of abdomen; small species.....**Anoecia** p. 151
- Dark stigmal suffusion of fore wings elongate and more linear (Fig. 52); hind tibiae about twice as long as antennae; with large tubercle on middle of dorsum of abdomen (difficult to see on flat-mounted specimens on slides but conspicuous in live material); very large species.....**Tubero-lachnus** p. 159
4. Cornicles on conspicuous cone-shaped areas (Fig. 153); ocular tubercles present but small; comparatively large robust forms; feeding on bark of stems and branches.....**Cinara** p. 153
- Cornicles pore-like, not on cone-shaped areas (Fig. 158); ocular tubercles absent; medium-sized elongate forms; feeders on needles **Eulachnus** p. 157

GENUS ANOECIA KOCH

*Key to Species of the Genus Anoecia**

1. Third antennal segment with about seven secondary sensoria, fourth and fifth antennal segments each with one or two secondary sensoria; dark forms.....**querci** (Fitch) p. 152
- Third, fourth, and fifth antennal segments rarely with secondary sensoria; light forms.....**oenotherae** Wilson p. 151

ANOECIA OENOTHERAE WILSON

Anoecia oenotherae Wilson, Canadian Entomologist, Vol. XLIII, No. 2, February, 1911, p. 63.

This subterranean aphid is recorded from Illinois for the first time. It is retained tentatively as a good species, but further investigations may reveal it to be a summer form of *Anoecia querci* (Fitch) as Baker (1916) has suggested. When Wilson described this plant louse he stated that the third segment has "three or four widely-separated sensoria, which are not as prominent as those in other species of *Anoecia*." Our alate viviparous females rarely have secondary sensoria on the third segment, and Miss M. A. Palmer reports that a cotypic slide of *oenotherae* Wilson examined by her "contains two alate viviparae, one shows no sensoria on antennal joint III and the other example shows only one or two."

A. setariae Gillette and Palmer (1924) is very similar and, as stated in a letter from Miss Palmer, "may be identical." Biological investigations are needed to settle the question definitely.

Data associated with our specimens, collected on roots of *Oenothera*, are as follows: Muncie (May 5) and Oakwood (July 8), 1928; Oakwood (July 22), Oregon (July 11), Rock Island (July 7), Seymour (July 20), and Starved Rock State Park (July 6), 1929.

* The alate viviparous females keyed here as separate species may represent a summer (*oenotherae*) form and spring and fall (*querci*) forms of a single variable species.

ANOECIA QUERCI (FITCH)

FIG. 68

Eriosoma querci Fitch, Fifth Report of the Noxious and other Insects of the State of New York, Transactions of the New York State Agricultural Society, Vol. XVIII, 1858 (printed 1859), p. 304.

What was presumably this species was first recorded from Illinois (near Rock Island) by Walsh (1862) as "*Eriosoma? cornicola* n. sp." It was again reported from Illinois by Thomas (1879) under the new specific name of "*Schizoneura panicola*." Davis (1910d) was the first to report this species from the state (northern Illinois) under the specific name of *querci* Fitch.

Baker (1916c) has given the best account of the habits and characters of this species. In addition to placing *Rhizobius cleusinis* Thomas and *Schizoneura panicola* Thomas as synonyms of this species (Osborn had previously placed the latter as a synonym of *corni* in sense of previous authors), Baker suggests that *Anoecia oenotherae* Wilson is "only another of the root-feeding forms of *querci*, which in this particular case was feeding upon *Oenothera*." Forbes and Hart (1895) have presented under the name of *Schizoneura panicola* Thomas much information regarding what are no doubt the summer or root forms of this species. Although they frequently found this form on roots of corn, they considered it as having little economic significance.

Both *cleusinis* Thomas and *panicola* Thomas, as shown by the cotypic material, belong to the genus *Anoecia*. Baker's (1916c) position in sinking *cleusinis* Thomas as a synonym, based upon rearings of Pergande, seems tenable to us, especially since the apterous cotypic material can not be separated from apterous forms of *querci* (Fitch). The cotypic slide of *panicola* is in such poor condition, and our present knowledge of the genus is so limited, that a specific determination is opinionative. Maxson has stated in a letter to us that it "is different than any species of this genus (*Anoecia*) with which I am acquainted." We believe that Baker is probably correct in considering *panicola* Thomas as a synonym of *querci*.

Since this species spends part of its life cycle as a summer form on the roots of grasses, etc., and has *Cornus* as its over-wintering host, the specific name of *querci* appears to be a misnomer. "Drifts" of *querci* Fitch from *Cornus* are frequently found on plants other than their hosts, as are many other species of migratory plant lice

Data associated with our specimens collected on various species of *Cornus* are as follows: Urbana (May 17), 1894; Catlin (Sept. 27), Danville (Sept. 18), Herod (Dec. 12), 1928; Decatur (Oct. 5), Kappa (Sept. 9, 22, Oct. 3), 1929; Humboldt (Nov. 12), 1930. Specimens of "drifts" or migrating specimens were collected as follows: Urbana (June 25), 1889; Urbana (Oct. 19), 1928; Homer Park (Oct. 23), Seymour (Oct. 30), 1929; Urbana (Sept. 28-Oct. 30), 1930. Data associated with apterous forms on roots of *Setaria*, *Zea*, *Erigeron* and undetermined grasses are as follows: Champaign (July 31), Polo (July 15), 1883; Urbana (May 20), 1887; Urbana (Oct. 10), 1890; Champaign (Oct. 17), 1894; Urbana (Sept. 27), 1930. Cotypic slide of *Rhizobius cleusinis* Thomas (Slide No. 8777) is from Carbondale, Illinois, on roots of *Eleusine indica*, September 3, 1877, and the cotypic slide of *Schizoneura panicola* Thomas (Slide No. 2770) is from St. Louis, Missouri, November, on roots of *Panicum glabrum*, collected by H. Pergande.

GENUS CINARA CURTIS

The life histories of the species in this genus are so uniformly similar that comments concerning them are not given under each species, as is the case in some of the more complex and migratory forms in other genera. Along with other closely related forms, the genus *Cinara* is considered to be among the most primitive of the living aphids.

The various species show strict fidelity to the pine family, or Pinaceae, upon which the entire non-migratory life cycle is spent. The aphids over-winter in the egg stage. The stem mothers produce apterous viviparous females, which in turn give rise to other apterous viviparous females, alate viviparous females, and finally alate or apterous males and oviparous females.

Key to Species of the Genus Cinara

1. First tarsal segment about one-fifth the length of the second segment exclusive of claws.....*pinicola* (Kaltenbach) p. 156
- First tarsal segment from about one-third to one-half the length of the second segment exclusive of claws.....2
2. Hind tibiae uniformly dark brownish.....3
- Hind tibiae with basal and apical portions dark brownish, area between yellowish brown, the two colors distinctly contrasting.....4
3. Third antennal segment approximately twice as long as hind tarsus exclusive of claws.....*strobi* (Fitch) p. 157
- Third antennal segment but slightly longer than hind tarsus exclusive of claws.....*difficilis* n. sp. p. 153
4. Hairs on antennae very short and spine-like, little if any longer than width of the antennal segments.....*laricis* (Hartig) p. 155
- Hairs on antennae longer, many of them at least twice the width of the antennal segments.....5
5. Tibiae of fore legs almost uniformly dark brownish; hair on hind tibiae not numerous, stout, rather spine-like, many erect particularly on basal half.....*pini* (Linnaeus) p. 156
- Tibiae of fore legs with basal and apical portions dark brownish, area between yellowish brown, the two colors distinctly contrasting; hairs on hind tibia numerous, rather fine and mostly reclinate*palmerae* (Gillette) p. 156

CINARA DIFFICILIS new species

FIG. 231

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 2.60.* Entire body dull with a fine waxy bloom easily seen under a microscope. Head and thorax dusky brown, the head with a conspicuous darker median line, the thorax with the tegulae, paraptera, and notal membranes reddish brown. Abdomen cinnamon brown with a slight pinkish cast; cornicles and the cone-shaped areas at the base of the cornicles, cauda, anal plate, and a transverse patch immediately anterior to the cauda are dark brown. There are four rows of small brownish spots longitudinally arranged on the dorsum of the abdomen. The first two antennal segments are concolorous with the head; the base of the third antennal segment is much lighter in color than the remaining portion of this segment which is a light chestnut brown; fourth, fifth, and sixth antennal segments uniformly light chestnut brown. Coxae and trochanters of all legs blackish brown; femora of all legs uniformly dark chestnut brown, except that the femora of the hind legs are

* All measurements in this paper are in millimeters.

slightly lighter at or near their base; tibiae dark chestnut brown with a slight tendency to be a shade or so lighter near the center of the segment, except for the tibiae of the hind legs which are uniformly brownish; tarsi dark chestnut brown. The last three apical segments of the beak are dark chestnut brown, the remaining segments are considerably lighter in color than the apical segments, and the apical portion of the long second segment is more or less spotted with dark brown areas from which arise hairs with a light colored base. Costal margin of wings deeply suffused with brown.

Head and appendages.—Average width of head across eyes, .69. Antennal segments with comparative lengths as follows: III—.29 to .39, average .35; IV—.10 to .16, average .14; V—.14 to .21, average .17; VI—.14 to .14, average .14 plus .03 to .04, average .03. The secondary sensoria are distributed as follows (Fig. 231): third antennal segment with six to nine sensoria, and with the exception of a single sensorium arranged in a straight row, the first sensorium being located about one-fifth of the length of the segment from the base; the fourth and fifth segments have a single, more or less centrally located, secondary sensorium in addition to the large primary sensorium. The ocular tubercles are present but are poorly developed. The beak almost reaches to the cornicles.

Thorax and appendages.—Fore wings with a prominent dark brownish suffusion along the costal margin; subcostal vein large and dark brown, interrupted or broken near stigmal area, therefore a clearly defined stigmal area lacking; median vein only once forked and feebly developed; radial sector, cubitus, and first anal veins strongly outlined; hind margin of wing slightly thickened at point of articulation with first anal and cubital veins. Tibiae of metathoracic legs slightly inwardly curved a short distance beyond the middle. Tarsi of metathoracic legs about one-fifth shorter than the length of the third antennal segment.

Abdomen.—The cornicles are situated on comparatively shallow cone-shaped areas which have their outer margin very irregular. The maximum dimensions of the cornicles plus the cone-shaped area are as follows: height, .16; width, .36. The cauda is one-third wider at the base than it is long; its sides are not rounded but arise to form an angle of slightly more than ninety degrees.

Hair.—Hair, wherever found, fine and not spine-like; on antennae almost twice as long as width of segment and quite erect for about one-half their length; on basal portion of hind tibiae quite erect and about one-fifth longer than width of segment, and on apical portion somewhat longer and more recumbent than those on the basal portion; on anal plate and cauda much longer than any other found on the body.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.71. Color, except for legs and a slight grayish-brown on the abdomen, identical with color characters as given for the alate viviparous female. The legs of this form are a dark chestnut brown except that one-half to one-third of the tibiae near their basal portions are light yellowish brown as are also the bases of the femora. Antennae colored as in the alate except in some specimens they are lighter in color as a whole.

Head and appendages.—Average width of head across eyes, .74. Antennal segments with comparative lengths as follows: III—.24 to .41, average .31; IV—.10 to .16, average .13; V—.14 to .19, average .17; VI—.10 to .14, average .12 plus .03 to .06, average .04. The secondary sensoria are confined wholly to the fifth antennal segment and range in number from one to two (two in only one case). The head is divided by a median line, the position of which is further emphasized by a median furrow which in some individuals makes the head appear bilobed or indented at its anterior margin. The beak is colored as in the alate viviparous female. The hind tibiae are shaped as the hind tibiae of the alate female; the hind tarsi exclusive of claws are subequal in length to the third antennal segment.

Abdomen.—Abdomen and structures similar to those described for the alate viviparous female. The cornicles vary from .31 to .43 and average .35. The cauda is broadly rounded.

Hair.—The hairs are similar to those described for the alate viviparous female except that those on the apical portions of the hind tibiae are slightly more upright.

Holotype.—Alate viviparous female; Herod, Illinois, June 28, 1931, on *Juniperus virginiana*, (Frison and Ross). The wings of the holotype are broken off a short distance from articulation with the thorax, a condition probably caused by the manipulation of attendant ants. On slide with two nymphs and one pupa. Slide No. 10598. *Morphotype*.—Apterous viviparous female; Herod, Illinois, June 16, 1930, on *Juniperus virginiana*, (Frison and Ross). Slide No. 10599. *Paratypes*.—Forty-two slides of alate viviparous females, apterous viviparous females, pupae and nymphs; all collected in Illinois on *Juniperus virginiana* by T. H. Frison, F. C. Hottes, and H. H. Ross. The localities and dates are as follows: Herod (June 21 and September 27), Anna (June 24), and Galena (June 10), 1929; Herod (June 16), 1930. Slides Nos. 10600-10625 and others unnumbered.

This species was discovered by investigating a covered runway in which an ant (*Crematogaster lincolata* Say) was seen to enter; the runway was located on a small woody branch of red cedar. In this protected situation a single alate viviparous female with mutilated wings was found. Examination of other and similar ant structures on the trunk and branches of the host tree revealed additional specimens. The specimens were usually in two's or three's but nearly one-hundred specimens were removed from one place where a branch had split away from the main trunk of the tree and then partially healed, the open and exposed crevice being walled over by the ants with mud and shreds of bark until it was effectively concealed. Specimens found at all three localities were associated with the same species of ant and cleverly concealed by the ant structures. The mutilated condition of the wings of all but one alate viviparous female may be due to the ants chewing off the wings.

The characters of the body of this species strongly suggest *Cinara rubicunda* (Wilson) described from *Juniperus communis* in Oregon. It may be separated from that species, however, by the venation. In this new species the median vein is but once-forked, whereas in *rubicundus* it is stated and illustrated as twice-forked. This species also comes close to *C. juniperi* DeGeer of Europe, but apparently may be separated from it on the basis of the longer beak.

Specimens of this species were submitted to Professor H. F. Wilson who kindly examined them and reported that these specimens "do not agree with any that I have." Other specimens were submitted to Miss M. A. Palmer, who reported that she did not know this form.

CINARA LARICIS (HARTIG)

Figs. 12, 75, 153, 213, 216

Lachnus laricis Hartig, Jahresberichte über die Fortschritte der Forstwissenschaft und forstlichen Naturkunde im Jahre 1836 and 1837. Berlin, 1839, p. 645.

Aphis laricis Walker, The Annals and Magazine of Natural History, Vol. II, second series, 1848, p. 102. *Homonym and synonym*.

This European as well as American species has not been previously recorded from Illinois. Although its host, the tamarack, *Larix laricina*, occurs as a specimen tree in numerous localities throughout the state, our material was taken only in the locality where the tamarack occurs as a native tree. Our determination of this species has been checked by Professor H. F. Wilson. Theobald (1929) and Wilson (1923) give good descriptions of the various forms except the oviparous female, which is described by Schouteden (1906). Patch (1912a) has presented descriptions and drawings, under the name of *Lachnus laricifex* Fitch, based upon specimens collected in Maine.

The placement of *laricis* Hartig (1837) in the genus *Lachnus* and its association with the larch (*Larix*) are sufficient to make this name valid according to Article 25a of the International Rules of Zoological Nomenclature.

Data associated with our viviparous specimens are as follows: Antioch, June 16, 1928.

CINARA PALMERAE (GILLETTE)

Lachnus palmerae Gillette, Annals of the Entomological Society of America, Vol. X, No. 2, June, 1917, p. 135.

This species is here recorded from Illinois for the first time. Our specimens were determined by Professor H. F. Wilson and at his suggestion sent to Professor C. P. Gillette and Miss M. A. Palmer for comparison with cotypic material. Such a comparison was made by Miss Palmer who found that our specimens checked with the types. The host of this species is spruce (*Picea* sp.). Gillette has described all forms of this species in detail.

Data associated with our specimens are as follows: Galena, July, 10, 1929.

CINARA PINI (LINNAEUS)

Aphis pini Linnaeus, Systema Naturae, Editio Decima, 1758, p. 453.

A widely distributed species not previously recorded from the state. It is a large species and feeds on the bark of pine (*Pinus* sp.). Theobald (1929) and Wilson (1923) give good descriptions and notes regarding this plant louse.

Data associated with our Illinois specimens are as follows: Decatur (Nov. 4), Havana (June 21), 1928; Chicago (June 8), 1930.

CINARA PINICOLA (KALTENBACH)

Lachnus pinicola Kaltenbach, Monographie der Familien der Pflanzenläuse, Aachen, 1843, p. 154.

This species, occurring in Europe as well as America, has not been previously recorded from Illinois. Good descriptions and notes regarding this plant louse are given by Theobald (1929) and Wilson (1923). We are indebted to Professor H. F. Wilson for checking our determination of this species.

Data associated with our specimens, all taken on *Picea* sp., are as follows: Champaign (June 7), 1886; Carbondale (June 4), Champaign (July 18), Galena (June 26), Herod (May 31), Kankakee (June 29), Oregon (June 27), Urbana (June 19), 1928; Galena (July 10), 1929.

CINARA STROBI (FITCH)

FIG. 67

Eriosoma strobis Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 69.

Our report of this species is the first actual record of its occurrence in Illinois. See Wilson (1923) for descriptions and notes regarding this aphid attacking white pines.

Data associated with our specimens, all taken on *Pinus strobus*, are as follows: Urbana (Nov. 1-5), 1928; Flora (June 18), Jerseyville (June 25), 1929.

GENUS EULACHNUS DEL GUERCIO

EULACHNUS RILEYI (WILLIAMS)

FIG. 60

Lachnus rileyi Williams, University Studies, University of Nebraska, Vol. X, No. 2, March, 1911, p. 24.

This species has been reported from Chicago, Morgan Park, and Urbana, by Davis (1914a). Following Williams and Davis we are considering it distinct from the European *Eulachnus agilis* (Kalt.), although the two forms are unquestionably very closely allied. The difference between *rileyi* and *agilis* is expressed by the presence in the latter of secondary sensoria on the third and sometimes fourth antennal segments and their lack, or rarity, in the former. Our records indicate that this elongate and active species, which spends its entire life upon pines, is widely distributed through the state. Good descriptions of all forms are given by Davis (1914).

Data associated with our specimens, all collected on *Pinus sylvestris*, *Pinus echinata*, *Pinus strobus*, or *Pinus* sp., are as follows: Urbana (Oct. 11, 12), 1889; Urbana (May 7), 1925; Antioch (June 15), Galena (June 26), Metropolis (June 1), Pekin (June 20), Quincy (June 6), Urbana (May 23, Sept. 26, Oct. 19), 1928; Macomb (May 4), Rock Island (July 7), 1929. Sexual forms taken at Urbana on October 19, 1928.

GENUS LONGISTIGMA WILSON

LONGISTIGMA CARYAE (HARRIS)

FIGS. 6, 7, 8, 18, 59

Aphis caryae Harris, A Report on the Insects of Massachusetts Injurious to Vegetation, Cambridge, 1841, p. 190.

This conspicuous and well-marked species is the largest aphid occurring in the United States. It was probably first recorded from



Fig. 18. A colony of apterous viviparous females and nymphs of *Longistigma caryae* (Harris) on the sycamore, *Platanus occidentalis*; Urbana, Oct. 14, 1929.

Illinois by Thomas (1879), who reported it as clustered on the underside of the limbs of the pig-nut hickory (*Carya porcina*) in summer. It is likely, too, that the specimens of this species studied and described by Walsh (1862) were from Illinois. Davis (1910) listed it as common throughout the state, and said that the sexual forms occurred during October in northern Illinois. Descriptions of the various forms, together with a short note on the biology of the species, were given by Weed (1891).

At various times this species occurs in such large numbers upon the boulevard trees (Fig. 18) in some cities that it becomes a considerable pest because of the dropping of honey-dew upon the sidewalks beneath. During the last few years in Illinois, however, we have never found it extremely abundant; in fact, have never been able to find it except in autumn. We have records of this species from sycamore (*Platanus occidentalis*), pecan (*Carya illinoensis*), and basswood (*Tilia americana*).

Data associated with our viviparous forms are as follows: Champaign (Sept. 6), 1886; Makanda (June 4), 1919; Urbana (Oct. 26), 1924; Marion (Dec. 5), 1927; Herod (Nov. 30), Homer Park (Oct. 23), Urbana (Oct. 5, 19, Nov. 6), 1928; Alton (Oct. 15), Urbana (Oct. 14), Woodstock (Aug. 6), 1929. Sexual forms have been taken at Decatur (Nov. 4), Herod (Nov. 29), Urbana (Oct. 19), 1928, Granite City (Nov.), and Urbana (Oct. 14), 1929.

GENUS TUBEROLACHNUS MORDVILKO

TUBEROLACHNUS SALIGNA (GMELIN)

FIG. 52

Aphis saligna Gmelin, Caroli a Linné, Systema Naturae, 13th Ed., Lipsiae, Tom. I, Pars. IV, 1790, p. 2209, No. 62.

LeBaron (1871) in the "Second Report on the Insects of Illinois" described this species as *Lachnus dentatus*, probably from Illinois specimens. It was reported under this latter name by Davis (1910d) as being a common species in northern Illinois, becoming very abundant in the fall, and a considerable nuisance on ornamental willows. This aphid is easily recognized because of its large size and prominent dorsal abdominal tubercle. It is restricted to willow (*Salix* sp.).

We are following Theobald (1929) in considering *saligna* as having priority over the specific name of *punctatus* (Burmeister) now in use in this country.

Data associated with our specimens are as follows: Decatur (Sept. 25), 1887; Elizabethtown (Oct. 12), Herod (Nov. 30), 1928; Edwardsville (Sept. 11), Urbana (Oct. 13, 14), 1929; Urbana (Aug. 26), Watson (Nov. 13), 1930.

SUPERTRIBE CHAITOPHOREA

KEY TO GENERA

1. Cornicles always present, varying from minute to large.....2
- Cornicles absent *Gypsoaphis* p. 167
2. Antennae with five segments (Fig. 232)..... *Sipha* p. 174
- Antennae with four segments (Fig. 230)..... *Paducia* new genus p. 167
- Antennae with six segments.....3
3. Cauda distinctly knobbed (Fig. 188)..... *Chaitophorus* p. 160
- Cauda rounded (Fig. 214).....4
4. Cornicles with apical portion swollen (Figs. 145, 146, 162) and wider than basal portion.....5
- Cornicles either cylindrical or with basal portion wider than apical portion (Fig. 152).....6
5. Cornicles without a distinct flange at apex (Fig. 162)..... *Plocamaphis* p. 172
- Cornicles with a distinct flange at apex (Fig. 145)..... *Clavigerus* p. 165
6. Cornicles cylindrical; third antennal segment long, twice or more as long as width of head through eyes.... *Amphicercidus* p. 160
- Cornicles with basal portion wider than apical portion, hence trapezoidal in shape (Fig. 152); third antennal segment shorter, much less than twice as long as width of head through eyes *Periphyllus* p. 170

GENUS AMPHICERCIDUS OESTLUND

AMPHICERCIDUS PULVERULENS (GILLETTE)

Figs. 144, 248

Aphis pulverulens Gillette, Journal of Economic Entomology, Vol. 4, No. 3, June, 1911, p. 324.

This species, originally described from Colorado, has not been previously recorded from Illinois. Our records indicate that it is a common species in the southern portion of the state. We have no records indicating its presence in the northern portion of the state, but since it occurs in Minnesota it should be present wherever its host occurs in Illinois. It shows a decided preference in Illinois for coral-berry growing in moist, somewhat shaded situations. This species produces a white flocculent secretion, is a bark feeder, and is never far removed from the ground. The sexual forms have been described by Gillette (1911).

Data associated with our apterous and alate viviparous female specimens, all collected on *Symphoricarpos orbiculatus*, are as follows: Elizabethtown (May 29), Golconda (May 31), Herod (May 29), Mattoon (June 10), Metropolis (May 31, June 1), Mt. Carmel (May 26), Quincy (June 6), Shawneetown (May 27), 1928; Flora (June 18), Hardin (June 25), Monticello (May 24), 1929.

GENUS CHAITOPHORUS KOCH

The forms constituting this group of plant lice have presented us with one of our most baffling problems, and it is evident from the statements of various students of the Aphididae (Patch, 1913a,

and Davis, 1910d) that others have faced the same unsatisfactory situation. With the exception of one species (*quercicola*), which is readily separated in the alate forms because of its conspicuously marked wings and in apterous forms because of its spiny condition, no good differential structural characters have been found. Comparative lengths of antennal segments, number of sensoria, etc., are quite variable in a series of apparently the same species. In all parts of Illinois our captures are readily separated on the basis of habitus and host plants into the following five forms: the distinct *quercicola* with marked wings on oaks, a medium-sized green or blackish form on willows such as *Salix nigra*, a minute whitish pellucid form on *Salix amygdaloides*, and two light-colored forms (one large and one small) on various species of *Populus*. Biological studies including numerous transfer tests of forms from one host to another are badly needed to throw light upon our present dilemma. Meanwhile it seems the best policy to keep separate the forms involved, however weak may be our key for their differentiation.

Key to Species of the Genus Chaitophorus

1. Veins of wings margined with fuscous (Fig. 62); stout dark spines on dorsum of abdomen in apterous forms..... *quercicola* Monell p. 164
- Veins of wings not margined with fuscous (Fig. 70), no stout dark spines on dorsum of abdomen in apterous forms.....2
2. Occurring on *Salix*.....3
- Occurring on *Populus*.....4
3. Species of minute size; abdomen partially pellucid or whitish; on *Salix amygdaloides*.....*pusillus* n. sp. p. 163
- Larger species; abdomen partially greenish or blackish; on various species of *Salix*.....*viminalis* Monell p. 165
4. Secondary sensoria on third antennal segment forming an irregular row (Fig. 250); transverse dark patches on dorsum of middle abdominal segments broad and rectangular in shape (Fig. 336).....*populifoliae* Oestlund p. 163
- Secondary sensoria on third antennal segment forming almost a straight row (Fig. 253); transverse dark patches on dorsum of middle abdominal segments narrower with lateral ends tapering and clear intersegmental areas more prominent (Fig. 335).....*neglectus* n. sp. p. 161

CHAITOPHORUS NEGLECTUS new species

FIGS. 253, 335

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.27. Head and thorax dusky brown. Abdomen (Fig. 335) light greenish-yellow, the dorsum marked with dusky-brown bars and spots, as follows: each segment anterior to cornicles typically with a transverse, elongate, diamond-shaped bar often extending almost the entire width of the segment, with a large lateral subquadrate spot, and with several small, variously shaped spots extending transversely between the lateral spots and forming a chain between the large transverse bands. Segments posterior to cornicles with dorsum, except for intersegmental areas, a solid dusky brown. Cornicles, cauda, and anal plate light dusky. First and second antennal segments concolorous with head, third antennal segment light brownish, usually

somewhat lighter at or near the base, remaining segments brownish with their apical portions darker. Femora usually yellowish basally and apically, middle portion light brownish, some specimens with the hind femora considerably darker than the others; tibiae uniformly yellowish; tarsi light brownish. Beak yellowish with apex brownish. Stigma and veins brown; posterior margin of wing in vicinity of anal vein brownish.

Head and appendages.—Average width of head across eyes, .39. Antennal segments with comparative lengths as follows: III—.30 to .39, average .33; IV—.14 to .21, average .17; V—.11 to .16, average .14; VI—.09 to .10, average .10 plus .27 to .40, average .34. Secondary sensoria (Fig. 253) usually confined to the third antennal segment, numbering from 7 to 13 and averaging 9, arranged in a straight row, sometimes fourth segment with a single sensorium. For a *Chaitophorus*, this species is remarkably constant in regard to numbers and arrangement of secondary sensoria. Primary sensorium on sixth antennal segment with a group of about 5 marginal sensoria at one side. Front of head with about six long hairs. Beak reaching about midway between first and second coxae.

Thorax and appendages.—Stigma of fore wings somewhat arched anteriorly, wing beyond apex of stigma distinctly narrower than at stigma. Second fork of media variable in position but always nearer to margin of wing than to the first fork or midway between them. All veins failing to reach the margin of the wing. Hairs on legs fine, long, and only slightly drooping.

Abdomen.—Cornicles about .06 long with closed reticulations at the apex, very little wider at base than at apex. Cauda .08 long, distinctly knobbed. Anal plate rounded.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.52. Head yellowish-brown, darkest on dorsum. Thorax brownish on dorsum with yellowish-green towards the lateral portions. Abdomen yellowish-green with two broad, longitudinal bands of brown on dorsum, bands confluent anteriorly with brown on thorax and on the segment posterior to the cornicles with each other. Brown marks on dorsum of entire body fashioned into a somewhat fork-shaped effect, outlined by the surrounding yellowish color of the body. Cornicles yellowish-green. Cauda and anal plate very light dusky brown. First two antennal segments concolorous with head, third antennal segment and basal half of fourth antennal segment yellowish, remaining portion of antennae brown. Legs and beak as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .37. Antennal segments with the following proportions: III—.27 to .29, average .28; IV—.14 to .17, average .16; V—.13 to .14, average .14; VI—.09 to .11, average .10 plus .16 to .37, average .30. There are no secondary sensoria; primary sensorium on sixth antennal segment with about six marginal sensoria to one side. All antennal segments lightly imbricated. Beak reaching just to or but slightly beyond mesothoracic coxae.

Thorax and abdomen.—Similar to thorax and abdomen of alate viviparous female except that the anal plate has a very slight indentation near the center of the posterior margin.

Holotype.—Alate viviparous female; Starved Rock State Park, Illinois, August 14, 1929, on *Populus deltoides*, (Frison and Hottes). On slide with paratypic apterous viviparous females and nymphs. Slide No. 10037. *Morphotype.*—Apterous viviparous female; some data as holotype. On slide with paratypic alate and apterous viviparous females and nymphs. Slide No. 10038. *Paratypes.*—Fourteen slides containing alate and apterous viviparous females, pupae, and nymphs, all collected in 1929 on *Populus deltoides* and *P. grandidentata* by T. H. Frison and F. C. Hottes as follows: Beach (August 29) and Starved Rock State Park (August 14). Slides Nos. 10039-10049 and others unnumbered.

This species is extremely close to *C. essigi* Gillette & Palmer and *C. populcella* Gillette & Palmer, from which it differs in having a larger number of sensoria on the third antennal segment and in having distinct bands on the dorsum. Specimens tentatively determined as *Chaitophorus populcella* G. & P. were submitted to Miss Palmer who pointed out the differences already mentioned and suggested that if the forms run constant it would be the safest procedure to describe them as new. At the same time she ventured the opinion that they are perhaps connecting links between *C. populcella* and *C. essigi*, which she says may sometime prove to be synonymous.

CHAITOPHORUS POPULIFOLIAE OESTLUND

FIGS. 250, 336

Chaitophorus populifoliae (Fitch) Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 38. *Misidentification.*

Chaitophorus populifoliae Oestlund proposed for *Chaitophorus populifoliae* (Fitch) Oestlund, Davis, Journal of Economic Entomology, Vol. III, No. 6, 1910, p. 489.

This species (Fig. 336) was redescribed by Davis (1910e), but credit for the specific name was given to Oestlund. Very little is known concerning the biology and distribution of this species.

Data associated with our specimens, all collected on leaves of *Populus deltoides* or *P. grandidentata*, are as follows: Cave-in-Rock (May 30), Elizabethtown (Oct. 12), Herod (Oct. 12), Starved Rock State Park (June 13), 1928; Elizabethtown (June 20), Farmer City (Sept. 22), Grayville (June 19), Oakwood (July 22), Starved Rock State Park (July 5, Aug 14), 1929; Starved Rock State Park (May 13), 1930.

CHAITOPHORUS PUSILLUS new species

FIGS. 70, 151, 252

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, .95. Head and thorax light brown. Abdomen yellowish, almost whitish, with a large light-brownish or buff spot on the dorsum. Cornicles fuscous; cauda and anal plate yellowish. Legs variable in color, usually yellowish, with tarsi and sometimes portions of femora distinctly fuscous. Stigma fuscous, veins of wings light brown. Beak yellowish except for extreme tip, which is fuscous.

Head and appendages.—Average width of head across eyes, .31. Antennal segments with comparative lengths as follows: III—.20 to .29, average .24; IV—.09 to .16, average .11; V—.11 to .14, average .13; VI—.07 to .09, average .08 plus .20 to .29, average .26. Secondary sensoria (Fig. 252) on third antennal segment ranging in numbers from 4 to 7 and averaging six; fourth and fifth segments with sometimes one or two sensoria each; sensoria usually arranged in a straight row. Primary sensoria on sixth antennal segment with a group of marginal sensoria at one side. Hair on antennae sparse, but very long and fine, being two to three times as long as the width of the segment. Beak reaching midway between the pro- and mesothoracic coxae.

Thorax and appendages.—Costal margin of wing in vicinity of stigma very much curved, stigma comparatively narrow, short, and bluntly pointed; second fork of media variable in position, usually midway between first fork and margin of wing.

Abdomen.—Cornicles (Fig. 151) typical for genus in shape; averaging .95 in length, imbricated very faintly and reticulated at apex. Cauda typical for genus, rarely extending beyond tip of anal plate which is rounded and not indented.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.09. Head, thorax, abdomen, cornicles, cauda and anal plate a pellucid yellowish-white. Apical portion of fifth antennal segment, base of sixth and apical portion of terminal filament are fuscous. Eyes reddish-brown. Legs concolorous with body except that tarsi are often somewhat fuscous.

Head and appendages.—Average width of head across eyes, .33. Antennal segments with comparative lengths as follows: III—.16 to .24, average .19; IV—.07 to .11, average .10; V—.09 to .11, average .10; VI—.07 to .09, average .09 plus .17 to .29, average .25. There are no secondary sensoria. The beak reaches to the end of the mesothoracic coxae.

Abdomen.—The cornicles and cauda have the same average length as similar structures in the alate viviparous female. The body is sparsely covered with fine but unusually long hair, the hairs average .14 in length.

Holotype.—Alate viviparous female; Starved Rock State Park, Illinois, July 6, 1929, on *Salix amygdaloides*, (Frison and Hottes). Slide No. 10680.

Morphotype.—Apterous viviparous female; same data as for *holotype*. On slide with numerous apterous viviparous females and nymphs. Slide No. 10681. *Paratypes.*—Thirty slides of alate and apterous viviparous females and nymphs, all collected on *Salix amygdaloides* in Illinois, by T. H. Frison, F. C. Hottes, and H. H. Ross, with localities and data as follows: Galena (July 10), Oakwood (July 22), Rock Island (July 7), and Starved Rock State Park (July 6-August 14, and September 10), 1929; Oakwood (May 9), and Starved Rock State Park (May 13), 1930. Slides Nos. 10682-10704 and others unnumbered.

This species shows a preference for the terminal leaves of *Salix amygdaloides* and occurs on both the dorsal and ventral leaf surfaces. Its minute size, pellucid appearance, and host are a combination of characters which distinguish it from other described species of *Chaitophorus*. The lack of good structural characters for the separation of the forms now considered as species has already been mentioned in our remarks concerning the genus as a whole.

CHAITOPHORUS QUERCICOLA (MONELL)

FIG. 62

Callipterus? quercicola Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 31. (Alate form described).

Chaitophorus quercicola Monell, *ibid.*, p. 32, (description of apterous form).

This species was originally described by Monell (1879) from specimens sent to him from Peoria, Illinois. Both Davis (1910d) and Baker (1917b) have placed *C. spinosus* Oestlund as a synonym of *quercicola*, and this placement seems to us to be correct, *spinosus* being described from apterous oviparous females. Davis (1910d) has also placed *Callipterus quercifolii* Thomas (1879) as a synonym of *quercicola* (Monell). The cotypic slide of *Callipterus quercifolii* Thomas in our collection (slide 7658) certainly is *C. quercicola* (Monell) as Davis has stated (1910d and 1913). This slide contains alate and apterous females in poor condition from Sauk City, Wisconsin, collected in June by Bundy on red oak leaves.

Data associated with our alate and apterous viviparous females, all collected on *Quercus macrocarpa*, are as follows: Antioch (June 16), Kankakee (June 29), Oregon (June 28), 1928. Davis reports the oviparous females from Kankakee, Oct. 13, 1908, and viviparous females from Heyworth, April 10, 1908.

CHAITOPHORUS VIMINALIS MONELL

FIG. 188

Chaitophorus viminalis Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 31.

The material in our collection strongly indicates that *C. viminalis* Monell and *C. nigrae* Oestlund are the same species, the latter being a dark phase of the former. Baker (1917b) held that *viminalis* and *nigrae* were distinct, mainly upon the reticulated condition of the skin of the apterous forms. We are not able to separate our series of slides upon this basis. Comparative lengths of antennal segments and distribution of secondary sensoria intergrade, too, in specimens which on the basis of color might be regarded as two species. In all parts of Illinois we have found the dark and light forms closely associated and intermixed on the same leaves and stems. This is rather unusual if they are different species.

Data associated with our specimens, all collected on various species of *Salix*, are as follows: Antioch (June 16), Carbondale (June 4), Elizabethtown (Oct. 12), Galena (June 26), Havana (June 21), Kankakee (June 29), Mattoon (June 10), Metropolis (June 1), Muncie (May 12), Quincy (June 6), Starved Rock State Park (June 13), Urbana (July 10), 1928; Beach (July 13, Aug. 29), Cairo (June 22), Chebanse (Apr. 24), Elizabethtown (June 20), Galena (July 10), Hardin (June 25), Muncie (April 17), Oakwood (Oct. 13), Olney (June 18), Oregon (July 11), Rock Island (July 7), Starved Rock State Park (Aug. 14), 1929; Robinson (April 14), Snyder (April 14), 1930. Slide No. 3784 in the Survey collection was compared with a slide mount of cotypic specimens "8/86 Mpls 26" in the collection of Dr. Oestlund.

GENUS CLAVIGERUS SZEPLIGETI

Key to the Species of the Genus Clavigerus

1. Cornicles about twice as long as their greatest diameter (Fig. 145).....*smithiae* (Monell) p. 166
- Cornicles three times or more as long as their greatest diameter (Fig. 146).....*populifoliae* (Fitch) p. 165

CLAVIGERUS POPULIFOLIAE (FITCH)

FIGS. 77, 146, 147

Aphis populifoliae Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 66.

This species is here reported for the first time from Illinois. Davis, in 1910c, used the specific name assigned to this species by Fitch in connection with another species for which Patch (1917) has proposed the name of *A. davisii*. All of our material has been collected on *Salix*. Descriptions of two heretofore undescribed forms are presented.

Data associated with our specimens are as follows: Elizabethtown (May 29, Oct. 12), Harrisburg (May 28), Oakwood (May 12, 23), Shawneetown (May 27), 1928; Elizabethtown (June 20), Galena (July 10), Oakwood (Nov. 7, Oct. 17), 1929; Calvin (April 15), Cobden (April 19), Oakwood (June 1), 1930.

ALATE MALE

Average length, 2.96. Color essentially similar to that of alate viviparous female. Average width of head across eyes, .64. Comparative lengths of antennal segments as follows: III—.59 to .61, average .60; IV—.39 to .43, average .40; V—.36; VI—.17 plus .26. Secondary sensoria on third, fourth, and fifth antennal segments, averaging as follows: III—35, IV—14, V—11, irregularly arranged, but confined to one side of the segment. Beak reaching to mesothoracic coxae. Prothorax with a large lateral tubercle. Cornicles .24 long, cauda .10, both structures similar in shape to those of alate viviparous female. Genitalia very dark brown.

APTEROUS OVIPAROUS FEMALE

Average length, 3.26. Color essentially similar to apterous viviparous female. Average width of head across eyes, .71. Comparative lengths of antennal segments as follows: III—.54 to .60, average .58; IV—.33 to .39, average .36; V—.30 to .36, average .34; VI—.16 to .17, average .17 plus .21. There are no secondary sensoria. Prothorax with lateral tubercles. Lateral tubercles on abdomen not constant but sometimes present. Cornicles .36 long, cauda .18 long, both similar in shape to those of apterous viviparous female. Sensoria on hind tibiae numbering between three and four hundred.

Allotype.—Alate male; Slide No. 8295, Oakwood, Illinois, October 7, 1929, on *Salix* sp., (T. H. Frison). On slide with male. *Morphotype*.—Apterous oviparous female; Slide No. 8294, same data as allotype. On slide with oviparous female.

CLAVIGERUS SMITHIAE (MONELL)

FIG. 145

Chaitophorus smithiae Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 32.

Specimens from Peoria, Illinois, formed the cotypic material from which this species was described. This large aphid with its bright orange cornicles is quite common on *Salix*. Specimens have been collected, also, on *Populus grandidentata* and *Acer saccharinum*. Descriptions of the previously undescribed sexual forms are presented here.

Data associated with our specimens are as follows: Normal (Aug. 31, Sept. 24), 1883; Chicago (Oct. 9), 1897; Mansfield (Sept. 22), 1921; Champaign (Sept. 26), Decatur (Sept. 18, Oct. 4), Fisher (Nov. 11), Homer Park (Oct. 23), Kankakee (June 29), Mahomet (Oct. 2), Urbana (Sept. 26), 1928; Duncan Mills (May 4), Oakwood (Oct. 13, 17), Urbana (Oct. 21), 1929; Fox Lake (May 14), Joliet (April 23), 1930. Mating pairs were collected November 11, 1928.

ALATE MALE

Average length from vertex to tip of anal plate, 2.32. Color essentially similar to alate viviparous female. Average width of head across eyes, .66. Comparative lengths of antennal segments as follows: III—.53 to .64, average .58; IV—.33 to .51, average .41; V—.31 to .34, average .32; VI—.16 to .19, average .17 plus .19 to .21, average .20. Secondary sensoria present on third, fourth, and fifth antennal segments, irregularly arranged on all segments.

apparently on all sides of the third segment but confined largely to one side of the fourth and fifth segments; average distribution as follows: III—95, IV—63, V—12. Prothorax with lateral tubercles. Four abdominal segments anterior to cornicles as well as the segment posterior to cornicles with lateral tubercles. Beak reaching middle of metathoracic coxae. Cornicles .19 long, cauda .08 long, otherwise similar to those of alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 3.39. Color essentially that of apterous viviparous female. Average width of head across eyes, .69. Comparative lengths of antennal segments as follows: III—.46 to .54, average .50; IV—.30 to .31, average .31; V—.23 to .29, average .26; VI—.11 to .16, average .13 plus .20. There are no secondary sensoria. Beak reaching to base of metathoracic coxae. Cornicles .29 long, cauda .14, both similar to those of the apterous viviparous female. Hind tibiae slightly swollen, with about 90 sensoria.

Allotype.—Alate male; Slide No. 7086, Homer Park, Illinois, October 23, 1928, on *Salix* sp., (Frison and Park). On slide with male, oviparous female, and nymph. *Morphotype*.—Apterous oviparous female; Slide No. 7019, Fisher, Illinois, November 11, 1928, on *Acer saccharinum*, (T. H. Frison).

GENUS GYPSOAPHIS OESTLUND

GYPSOAPHIS OESTLUNDI HOTTES

FIGS. 209, 314

Aphis loniceræ Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. I, p. 26. *Name preoccupied.*

Gypsoaphis oestlundii Hottes, Proceedings of the Biological Society of Washington, Vol. 43, October 7, 1930, p. 181. *New name.*

This species was first recorded from Illinois by Davis (1910e) by the name given it in the original description. It is peculiar among the supertribe Chaitophorea of Illinois in that the cornicles are lacking. This plant louse is partial to the leaves and more terminal shoots of the red honeysuckle (*Lonicera* sp.)

Data associated with our records of this species are as follows: Antioch (June 15), Galena (June 26), Mt. Carroll (June 25), Oregon (June 28), Rock Island (June 24), 1928; Decatur (May 12), Urbana (May 26), 1929.

PADUCIA new genus

Antennae four-segmented (Fig. 230) and much shorter than the body. Antennae, legs, and body covered with numerous long hairs as in *Lachnus*. Head (Fig. 76) very broad and without antennal tubercles. Media of fore wings (Fig. 55) once-forked, hind wings with both media and cubitus present. Cornicles (Fig. 149) long and greatly swollen, constricted near base and before flange at apex. Cauda (Fig. 190) elongate, constricted in middle; tip rounded, almost knobbed. Anal plate very broad. Lateral margins of abdomen (Fig. 313) in alate viviparous female with large well-developed lateral tubercles; apterous oviparous females with lateral glands on the abdomen poorly developed.

Genotype, *Melanoxantherium antennatum* Patch, by original and present designation.

This genus has been placed in the supertribe Chaitophorea and probably is most closely related to the tribe Pterocommini, but it might be considered as representing a new tribe because of its four-segmented antennae and elongate constricted cauda.

PADUCIA ANTENNATA (PATCH)

Melanoxantherium antennatum Patch, Maine Agricultural Experiment Station, Bulletin 213, June, 1913, p. 87.

This unique and curious plant louse has not as yet been definitely associated with its host. Our first specimen, an alate viviparous female, was found resting on a fern leaf, and the oviparous females were first noticed on the surface of a small stream flowing into the Salt Fork River near Oakwood, Illinois. Subsequently a few specimens were found climbing over rocks protruding from the stream. The restriction of these oviparous females to an area of stream not exceeding forty feet in length and two to four feet in width is significant and indicates the host plant was somewhere in the immediate neighborhood. Although a thorough search failed to locate the host, some evidence was obtained to indicate that this aphid occurred on plant roots exposed by the erosive action of the stream. The typical specimens described by Patch were collected "on and in a pump which stands beneath an old willow," indicating that willow is probably the host.

We are associating the alate and oviparous females on the basis of similar cornicles and numerous other peculiarities.

This species and the new genus to which it has been assigned have no near relatives and may be sharply and distinctly separated from all other Aphiidae. The cornicles, cauda, and anal plate strongly suggest similar structures of *Amphorophora solani* Thomas, but the lack of antennal tubercles, the once-forked media, the lateral glands, and, most significant of all, the four-segmented antennae at once sever all attempts to associate the two species. Tentatively, we have considered this new form as most closely related to the tribe Pterocommini.

Since the alate viviparous female has not been previously described, and the oviparous female but briefly, we are presenting detailed descriptions of these two forms.

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.36. Head and thorax dark brown, boundaries of thoracic sclerites particularly darkly outlined. Abdomen mostly brown, lighter yellowish-brown areas on both sides and posterior to large, median, brownish spot, with lateral tubercles arising from brownish areas; cauda and anal plate dark brown; cornicles dark brown, darkest near base and posterior to widest portion of cornicles. First and second antennal segments brownish but lighter in color than head, second segment a little more yellow than first segment, third antennal segment dark brown except for extreme tip of segment which is yellowish, fourth segment essentially brownish becoming more yellowish-brown near base. Legs brown; femora lighter at base than elsewhere; tibiae almost uniformly brown, darkest at apices; tarsae somewhat lighter in color

than tibiae. Veins of fore wings brown; base of radius, cubitus, and anal veins more distinctly margined with brown than other veins. Beak brownish. Body and appendages with numerous long hairs.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative length as follows: I- .10; II- .10; III- .55; IV- .11 plus .41. Third antennal segment (Fig. 230) with nineteen to twenty-three secondary sensoria which are irregularly arranged but mostly confined to one side of the segment. The beak extends to the base of the coxae of the metathoracic pair of legs.

Thorax and appendages.—Prothorax with three pairs of lateral glands or tubercles. Stigma of fore wings (Fig. 55) narrow, distinctly pointed, and with a well-developed brownish accessory vein; media once-forked, hind wings with both medius and cubitus present.

Abdomen.—Four pairs of tubercles (Fig. 313) on lateral portion of abdomen anterior to cornicles, and a single pair of tubercles posterior to the cornicles, some of the tubercles appear to arise from low volcano shaped areas. The cornicles (Fig. 149) are about four times the length of the cauda and are weakly imbricated just before their apex. Cauda (Fig. 190) somewhat narrowed at base and distinctly constricted beyond middle, with two pairs of hairs on lateral margins. Anal plate wide and distinctly rounded.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.02. Body and appendages clothed with numerous long hairs as in alate viviparous female. Head, thorax, and abdomen essentially dark chocolate brown shading to almost black in some places; area at base of cornicles more noticeably yellowish and contrasting with the cornicles, which are dark brown to almost black; cauda and anal plate dark brown to blackish. First, second, and third antennal segments mostly concolorous with head; fourth segment at base about concolorous with other segments but lighter beyond sensoria. Legs essentially concolorous with the body, somewhat darker at apices than at bases; tarsi lighter in color than the other segments. Beak brownish, with terminal segments darker.

Head and appendages.—Average width of head across eyes, .49. Antennal segments with comparative length as follows: III- .37 to .57, average .45; IV- .10 to .14, average .12 plus .31 to .39, average .35. There are no secondary sensoria. Head sometimes with two glands on dorsum but occasionally with only one or none. The beak reaches about to the metathoracic pair of legs and sometimes beyond.

Thorax and appendages.—Prothorax with three pair of lateral glands as in the alate viviparous female. Mesothorax on dorsum separated from metathorax by an almost continuous row of glandular structures. All femora with large oval sensoria. Hind tibiae with from eight to twenty exceedingly small sensoria, which are extremely difficult to distinguish from the light colored bases of the hairs.

Abdomen.—Four double rows of glandular structures on the lateral and mid-lateral surfaces anterior to the cornicles; lateral portion of abdomen posterior to cornicles always with two pairs of glandular structures and occasionally three pairs (possibly three is the normal number but the third and more dorsal pair is smaller than the others and more difficult to distinguish). The cornicles are shaped as in the alate viviparous female and are faintly imbricated at the constricted area near the apex; in some specimens these imbrications are indented all over the surface of the cornicle but are extremely faint. The tip of the abdomen always extends beyond the anal plate, and may even extend beyond the constriction of the cauda so that only the extreme tip of the cauda may be seen unobstructed. The tip of the cauda is very "bushy," the hairs, which are difficult to count, average about six pairs on a side. The abdomen of the oviparous female usually contains only two very large eggs.

Morphotype.—Alate viviparous female; Starved Rock State Park, Illinois, July 6, 1929 (Frison and Hottes). Host unknown.

Our material, in addition to the single, previously unknown alate viviparous female, consists of oviparous females, collected at Oakwood, Illinois, on November 7 and 10, 1929 (T. H. Frison) and November 9, 1929 (H. H. Ross). One of the specimens taken on November 7 is aberrant in that the cornicles are not as swollen as in typical specimens. Host in all cases unknown. Our oviparous females have been compared with a cotype slide of this species kindly furnished by Dr. Patch.

GENUS PERIPHYLLUS VAN DER HOEVEN

(SUBGENERA PERIPHYLLUS VAN DER HOEVEN AND NEOTHOMASIA BAKER)

Key to the Species of the Genus *Periphyllus*

1. Veins of fore wings conspicuously margined with dark fuscous (Fig. 54) *populicola* (Thomas) p. 172
- Veins of fore wings not margined with fuscous.....2
2. Secondary sensoria of third antennal segment numerous, varying in number from fourteen to over twenty; dorsum of abdomen with brownish markings; sixth antennal segment with terminal filament at least three times as long as basal portion *lyropictus* (Kessler) p. 170
- Secondary sensoria of third antennal segment few, varying in number from six to ten; dorsum of abdomen without brownish markings; sixth antennal segment with terminal filament less than three times as long as basal portion.....
- *negundinis* (Thomas) p. 170

PERIPHYLLUS LYROPICTUS (KESSLER)

Chaitophorus lyropictus Kessler, Nova acta Academie Caesareae Leopoldino-Carolinae Germanicae Naturae Curiosorum, Band LI, No. 2, 1886, p. 171.

This large species, which inhabits the under surface of the leaves of maples, has been previously reported from Chicago and the near vicinity by Gillette (1909d) and Davis (1910d) under the name of *Chaitophorus aceris* Linn. The entire life history is spent upon its host. No dimorphs, as in *P. negundinis*, have thus far been observed.

All of our specimens have been collected on hard maple, *Acer saccharum*. Data associated with our specimens are as follows: Decatur (Oct. 2, Nov. 22), 1928; Decatur (Oct. 21), Urbana (Oct. 29), Waukegan (July 13, Aug. 29), 1929; Urbana (May 20), 1930. Our earliest record for the alate and apterous viviparous females at Urbana is May 20. Males and oviparous females are found in Illinois in September and October. A mating pair was observed at Urbana on October 29, 1929.

PERIPHYLLUS NEGUNDINIS (THOMAS)

FIGS. 152, 331

Chaitophorus negundinis Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 10.

This species is of special interest because of the production of the so-called "dimorphs," which are readily recognized by peculiar leaf-like flabellae protruding from the sides of the abdomen and head (Fig. 331). Our best information concerning these dimorphs is given in two

papers by Davis (1908b and 1910a). In the locality of Urbana, the dimorphs appear in June. Later in the season they are replaced by the normal forms. A related European species, *P. testudinatus* Thornton, has similar dimorphs.

At times this plant louse becomes so abundant on box elder in Illinois that it is exceedingly obnoxious, for the honey dew covers the

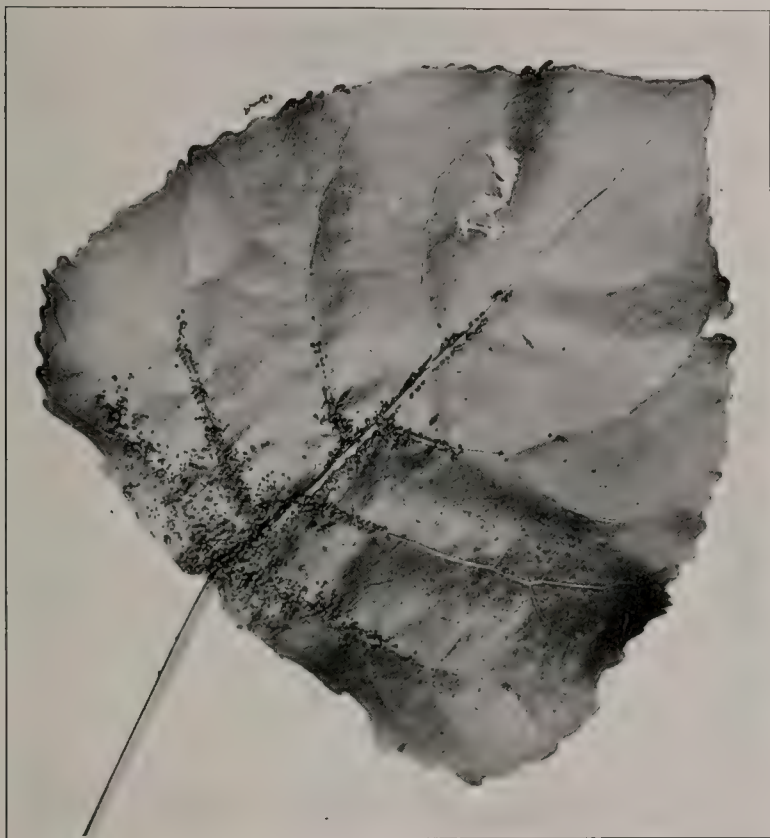


Fig. 19. Characteristic grouping of a colony of *Periphyllus populiicola* (Thomas) on upper side of a leaf of the cottonwood, *Populus deltoides*; Champaign, Sept. 9, 1929.

sidewalks beneath infested trees. Our records indicate it is common and widely distributed in all parts of the state. The best general account regarding it is given by Webster (1917).

The cotype specimens from which the original description was made are mounted on Slide 2775 of the Survey collection. Data associated with this slide mount of alate and apterous viviparous females are as follows: Peoria, Illinois, June, collected by Miss Smith, on *Acer Negundo*.

Data associated with our specimens, all collected on *Acer Negundo* are as follows: Normal (Sept. 24), 1883; Normal (May 12, 14), 1884; Antioch (June 15), Carbondale (June 4), Champaign (May 17, 21), Galena (June 26), Havana (June 21), Kankakee (June 29), LeRoy (June 20), Mattoon (June 10), Metropolis (May 31), Mt. Carmel (May 26), Mt. Carroll (June 25), Oregon (June 27), Pekin (June 20), Quincy (June 6), Shawneetown (May 27), Starved Rock State Park (June 12, 13), Urbana (May 24, June 7, Oct. 1), 1928; Collinsville (Sept. 11), Effingham (June 18), Macomb (May 4), Rantoul (April 24), Rock Island (July 7), Springfield (May 2), 1929.

PERIPHYLLUS POPULICOLA (THOMAS)

FIGS. 19, 54

Chaitophorus populicola Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 10.

This dark-colored aphid (Fig. 19), with wing veins bordered with fuscous (Fig. 54), is one of the most common aphids on poplar in Illinois. Dimorphic forms, such as are produced in summer by *P. negundinis* (Thomas), are not produced by this species. It is partial to water-sprouts or new and succulent growth. Since the description by Thomas, based on Illinois material, it has been recorded from the state by Davis (1910d). Wilson (1910b) made this species the type of a new genus called *Thomasia*. Finding that *Thomasia* Wilson had been used previously for another genus of insects, Baker (1920) proposed the generic name of *Neothomasia* for the same insect. We are considering *Neothomasia* as a subgeneric complex.

Cotypic specimens of this species were found among the recently discovered Thomas types in our collection. These cotypic alate and apterous specimens, in poor condition but easily recognizable as this species, are mounted in damar balsam on Slide No. 8177. They were collected at Carbondale, Illinois, July 19, 1877, on sprouts of *Populus*.

Data associated with our alate and apterous specimens, all collected on *Populus* sp., are as follows: Pekin (Aug. 8), 1882; Champaign (July 15, 27), Danville (Sept. 18), Elizabethtown (Oct. 12), Galena (June 25), Havana (June 20), Metropolis (June 1), Morton (July 22), Muncie (Aug. 8), Oakwood (July 18), Oregon (June 27, 28), Pekin (July 22), Quincy (June 6), Urbana (July 27), 1928; Cairo (June 22), East St. Louis (June 24), Edwardsville (Aug. 11), Eldorado (June 9), Elizabethtown (June 20), Galena (July 10), Grayville (June 19), Hillsboro (Sept. 10), Kansas (June 17), Oakwood (Oct. 13, 17, Nov. 10), Richmond (July 12), Rock Island (July 7), Starved Rock State Park (July 5), 1929; Oakwood (Oct. 22), Starved Rock State Park (May 13), 1930. We have taken the sexual forms at Oakwood, Illinois, on October 13, 17, and November 10, 1929, and October 22, 1930.

GENUS PLOCAMAPHIS OESTLUND

Key to Species of the Genus *Plocamaphis*

1. Body flocculent in living specimens, cornicles distinctly swollen and well developed (Fig. 162), secondary sensoria on third antennal segment averaging about twenty....*flocculosa* (Weed) p. 173
- Body not flocculent in living specimens, cornicles not distinctly swollen and weakly developed (Fig. 161), secondary sensoria on third antennal segment averaging about thirteen.....*terricola* n. sp. p. 173

PLOCAMAPHIS FLOCCULOSA (WEED)

Melanoxanthus flocculosum Weed, Insect Life, Vol. III, No. 6, March, 1891, p. 291.

This species has not previously been reported from Illinois. It is a bark feeder. Because of its body being very flocculent it is quite conspicuous on the bare and leafless branches of its host. The sexual forms have been described by Weed.

Data associated with our specimens, all taken on *Salix* sp., are as follows: Elizabethtown (Oct. 12), Herod (Nov. 30), 1928; Kankakee (July 25), Mounds (June 21), Oakwood (Oct. 17, Nov. 10), Oregon (July 11), 1929. We have taken the oviparous females in October and November. Eggs were being deposited on willows at Herod, Illinois, on November 30, 1928.

PLOCAMAPHIS TERRICOLA new species

FIGS. 161, 214, 256

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 2.46. Head and thorax dusky cinnamon brown; abdomen light cinnamon brown with darker brown on outer margin of cauda; anal plate slightly darker than the abdomen and reddish tinge less in evidence. First antennal segment concolorous with the head, second segment and basal portion of third segment light brown, remainder of antennae a dusky brown. Coxae, trochanters, and basal portion of femora light brown; remainder of femora, tibiae, and tarsi dark brown, particularly apical ends of tibiae and tarsi. The beak is mostly light brownish shading to dark brown at its apex. Wings with the stigma and the base of wings slightly suffused, the veins are well defined and light brown in color.

Head and appendages.—Average width of head across eyes, .66. Antennal segments with comparative lengths as follows: III- .46 to .50, average .49; IV- .36 to .36, average .36; V- .31 to .36, average .33; VI- .17 to .20, average .18 plus .31 to .43, average .39. The secondary sensoria are limited to the third antennal segment (Fig 256) and with the exception of one or two are arranged in a straight row; in number they average about 13; the terminal filament is more blunt than usual; hairs on antennae fine and fairly numerous, those on the third antennal segment from subequal to one and one-half times as long as width of segment. The beak is unusually long, always extending to the tip of the anal plate and often beyond.

Thorax and appendages.—Fore wings with the second fork of media variable in relation to the first fork and margin of the wing, either closer to first fork or midway between first fork and margin of the wing; and in one specimen M_2 is entirely lacking. The second segment of the hind tarsi, exclusive of claws, is about as long as the cornicles but in several examples it is slightly longer. The prothorax has a pair of large, well-developed lateral tubercles.

Abdomen.—At least three abdominal segments with well-developed lateral tubercles anterior to the cornicles. The cornicles (Fig. 161) are feebly developed and without a flange, are but slightly swollen and difficult to locate because of being lighter in color than the abdomen and not protruding beyond it; their length varies from .13 to .17 and averages .15. The cauda (Fig. 214) is much shorter than the anal plate and varies in length from .10 to .15 and averages .13. The anal plate (Fig. 214) is unusually well developed, often having its sides almost parallel and its posterior margin only slightly rounded.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 3.08. General color about as described for the alate viviparous female; differs in that the antennae and legs are darker in color. The dorsum and lateral portions of thorax and certain small areas in the abdomen are distinctly dusky brown.

Head and appendages.—Average width of head across eyes, .73. Antennal segments with average comparative length as follows: III-.40; IV-.30; V-.30; VI-.17 plus .36. The secondary sensoria are restricted to the third antennal segment and vary in number from one to four. The beak is similar to that of the alate viviparous female but usually extends only to the base of the cornicles.

Abdomen.—Lateral tubercles, cauda, anal plate, and cornicles as in the alate viviparous female.

Holotype.—Alate viviparous female; Beach, Illinois, July 13, 1929, on *Salix* sp., (Frison and Hottes). Slide No. 10659. *Morphotype.*—Apterous viviparous female; Beach, Illinois, July 13, 1929, on *Salix* sp., (Frison and Hottes). Slide No. 10660. *Paratypes.*—Thirty-four slides of alate and apterous viviparous females, pupae and nymphs; all collected at Beach, Illinois, July 13 and August 29, 1929, on *Salix* sp., (Frison and Hottes). Slides Nos. 10661-10679 and others unnumbered.

This species was found on the roots and near the crown of a species of *Salix* growing in the sand not far from the shore line of Lake Michigan. It may be separated from *Plocamaphis flocculosum* (Weed) by not being flocculent and terrestrial as well as by morphological characters, the most noticeable of which is the fact that the cornicles are much shorter and distinctly less swollen. In spite of the fact that the median vein has two forks instead of one, this species is perhaps most closely allied to *Plocamaphis braggi* Gillette and Palmer. In addition to venational characters it may be separated from this latter species by its larger cornicles and difference in comparative lengths of antennal segments.

GENUS SIPHA PASSERINI

SIPHA FLAVA (FORBES)

Chaitophorus flavus Forbes, Thirteenth Report of the State Entomologist of the State of Illinois, May 31, 1884, p. 42.

Although the sorghum aphid was described from Illinois by Forbes in 1884, its life history was mainly unknown until the studies of Davis (1909a) were published. The general details of the life history are similar to most other non-migratory species, except that some evidence was obtained by Davis to lead him to believe that the stem mothers are winged. The sorghum aphid is sometimes abundant enough to cause serious damage to broom corn and sorghum in Illinois. In Porto Rico it has frequently been a serious pest of young sugar cane.

Data associated with material in our collection are as follows: Heyworth (Aug. 11), 1883; Champaign (May 7), 1886; Urbana (Sept. 11), 1888; Havana (June 26), 1907; Carbondale (June 4), Decatur (Nov. 4), Mt. Carmel (May 26), 1928; Mitchell (June 25), 1929.

Lectotypic slide, No. 3152, selected by Frison (1927), contains an alate viviparous female collected at Champaign, Illinois, July 25, 1883, on sorghum by S. A. Forbes. Paratypic slides, Nos. 3151, 3153-3156, are associated with the same data as the lectotype slide.

SUPERTRIBE APHIEA

KEY TO GENERA

1. Cornicles absent or minute.....2
- Cornicles present and conspicuous.....3
2. Abdomen with lateral tubercles (Fig. 312); cornicles absent; body not elongate; basal portion of sixth antennal segment much shorter than fifth segment.....*Asiphonaphis* p. 225
- Abdomen without lateral tubercles; cornicles present but minute; body elongate; fifth and basal portion of sixth antennal segments about equal in length.....*Brachycolus* p. 228
3. With a caudal projection (supra-anal process) situated above cauda (Fig. 206).....*Cavariella* p. 229
- Without a caudal projection above cauda.....4
4. Antennae five-segmented (Fig. 232).....*Cerosipha* p. 229
- Antennae six-segmented (Fig. 266).....5
5. Media of fore wings normally branched once (Fig. 70).....*Toxoptera* p. 241
- Media of fore wings normally branched twice (Fig. 57).....6
6. Hind wings with cubitus lacking (Fig. 89) or only partially developed (Fig. 93).....7
- Hind wings with cubitus well developed (Fig. 91).....8
7. Cornicles without a flange (Fig. 136); secondary sensoria numerous on third, fourth and fifth segments; hind tibiae between four and five times as long as cornicles.....*Alphitoaphis* p. 175
- Cornicles with flange (Fig. 135); secondary sensoria few or lacking on fourth and fifth segments; hind tibiae about three times as long as cornicles.....*Hysteroneura* p. 232
8. Cornicles cylindrical or tapering (Fig. 131).....*Aphis* p. 176
- Cornicles more or less swollen (Fig. 160) with distinct constriction before apical flange.....9
9. Cornicles about as long as basal portion of sixth antennal segment.....10
- Cornicles much longer than basal portion of sixth antennal segment.....*Rhopalosiphum* p. 234
10. Cauda short, width at base about equal to length (Fig. 204).....*Brevicoryne* p. 228
- Cauda elongate, much longer than width at base (Fig. 199).....*Hyalopterus* p. 231

GENUS ALPHITOAPHIS HOTTES

ALPHITOAPHIS LONICERICOLA (WILLIAMS)

FIGS. 79, 93, 136

Aphis lonicericola Williams, University Studies, University of Nebraska, Vol. X, No. 2, March, 1911, p. 45.

This comparatively rare aphid is here recorded for the first time from Illinois. It causes the terminal leaves of its host, the red honey-suckle, to curl. A complete account of the life history of this non-migratory species, giving descriptions of all the various forms, has never been published.

Data associated with our specimens, all collected on *Lonicera* sp., are as follows: Antioch (June 15), Galena (June 26), Mt. Carroll (June 25), Oregon (June 28), 1928; Oakwood (June 1), 1929.

GENUS APHIS LINNAEUS

(SUBGENERA APHIS LINNAEUS AND ANURAPHIS DEL GUERCIO)

Key to the Species of the Genus Aphis¹

1. Dorsum of abdomen with a large dark patch or saddle-like area super-imposed on a lighter ground color (Fig. 4).....2
- Dorsum of abdomen of a uniform light or dark color, or at the most with lateral dark spots, narrow median, entire or interrupted, transverse bars, or dark areas around or posterior to the bases of the cornicles (Fig. 23).....8
2. Cauda and anal plate or both brown, decidedly darker than venter of abdomen; cornicles dark brown or blackish, sometimes lighter towards apex.....3
- Cauda and anal plate red, concolorous with venter of abdomen (both appearing yellow in cleared specimens), cornicles pale, sometimes slightly dusky near apex.....*rociadae* Cockerell p. 214
3. Cornicles either without imbrications, or with them only indistinctly developed, the sides of the cornicles appearing practically smooth.....4
- Cornicles with distinct, fine, close imbrications, giving the sides of the cornicles a minutely serrate appearance.....6
4. Cornicles less than twice length of cauda; cornicles practically without imbrications.....*padi* Linnaeus p. 209
- Cornicles distinctly longer than twice length of cauda; cornicles with feeble imbrications.....5
5. Fourth antennal segment with more than 15 sensoria; on apple.....*rosea* Baker p. 214
- Fourth antennal segment with less than 10 sensoria; on thistle.....*cardui* Linnaeus p. 185
6. Third antennal segment with more than 25 sensoria.....*tulipae* Fonscolombe² p. 222
- Third antennal segment with less than 25 sensoria.....7
7. Cornicles and cauda subequal in length; migrating between apple and clover.....*bakeri* Cowen p. 181
- Cornicles two or three times length of cauda; making a leaf-curl on *Viburnum* (Fig. 28).....*viburnicola* Gillette p. 223
8. Abdomen bright yellow with a very large black spot at the base of each cornicle.....*nerii* Fonscolombe p. 206
- Abdomen either not a bright yellow or without such a very large spot at the base of the cornicles.....9
9. Cornicles subequal to only one-half length of cauda.....10
- Cornicles subequal to, or greater than, entire length of cauda.....11
10. Fourth antennal segment with secondary sensoria (4-5); third antennal segment with more than 10 sensoria.....*debilicornis* Gillette and Palmer p. 191
- Fourth antennal segment normally without sensoria, rarely with one or two; third antennal segment with less than 10 sensoria.....*spiraephila* Patch p. 222
11. Cornicles smooth, entirely without imbrications; species forming a tight leaf-fold on *Solidago* (Fig. 27).....*solidaginifoliae* Williams p. 220

¹ The preparation of a key for the recognition of the Illinois species of plant lice belonging to the genus *Aphis* has proved to be a difficult and highly unsatisfactory undertaking. This key is submitted with the realization that it is imperfect and that it demands a partial knowledge of the colors of living aphids as well as the structures revealed by slide preparations. The key has been made by a study of many individuals of each species and an effort has been made to take into consideration reasonable variation. The inability to easily separate in a key certain forms at present considered as separate species reflects the need for pains-taking morphological and biological studies within the genus, studies of a character not possible for us to carry to completion at this time.

² We have not examined alate viviparous females of this species but have placed it in the key on the basis of the description of Theobald (1927).

- Cornicles with imbrications, usually distinct, especially on basal portion, but only weakly developed in the case of *persicae-niger*.....12
- 12. Antennae with numerous conspicuous setae as long as, or longer than, the width of the segments of the antennae; on *Populus*.....*maculatae* Oestlund p. 201
- Antennae with only inconspicuous, translucent setae, usually difficult to find; not on *Populus*.....13
- 13. Sensoria on third antennal segment arranged in a more or less straight and regular row.....36
- Sensoria on third antennal segment not arranged in a straight row, being scattered more indiscriminately over the surface of the segment14
- 14. Cauda elongate, constricted near the middle (Fig. 197), always two or three times its width at the middle.....23
- Cauda shorter, conical (Fig. 194), spatulate (Fig. 193), or broadly rounded (Fig. 191), not constricted near middle.....15
- 15. Cornicles subequal to cauda in length.....16
- Cornicles longer than cauda.....17
- 16. Fourth antennal segment with more than 10 sensoria; on *Physocarpus*.....*neilliae* Oestlund p. 205
- Fourth antennal segment normally lacking sensoria; on *Cornus*.....*caliginosa* Hottes and Frison p. 182
- 17. Terminal filament of sixth antennal segment less than twice length of cornicles.....19
- Terminal filament of sixth antennal segment twice or more than twice length of cornicles.....18
- 18. Cornicles subequal to or only slightly greater than length of base of sixth antennal segment.....*crataegifoliae* Fitch p. 190
- Cornicles at least twice as long as base of sixth antennal segment.....*persicae-niger* Smith p. 209
- 19. Abdomen a very dark green, appearing almost bluish or black; hind tibiae usually pallid with the apex darker; on *Sambucus*.....*sambucifoliae* Fitch p. 218
- Abdomen red or yellow with darker lateral or caudal patches; hind tibiae entirely black or blackish brown, sometimes with a central lighter area.....20
- 20. Abdomen with four pairs of large lateral tubercles anterior to cornicles.....*feminea* Hottes p. 193
- Abdomen with only one or two pairs of large lateral tubercles anterior to cornicles.....21
- 21. Sixth antennal segment with terminal filament not more than twice the length of the base; a subterranean or semi-subterranean species on the roots and crowns of dandelion (*Taraxacum* sp.).....*knowltoni* Hottes and Frison p. 199
- Sixth antennal segment with terminal filament more than twice length of base, often three times or more; not subterranean, inhabiting leaves and stems.....22
- 22. Color of abdomen distinctly reddish brown; distance from second fork of media to closest edge of wing four-fifths or more times the distance from second fork to first fork of media; fourth antennal segment with 2 to 4 sensoria.....*viburniphila* Patch p. 224
- Color of abdomen yellow; distance from second fork of media to closest edge of wing less than two-thirds of the distance between first and second forks of media; fourth antennal segment with 7 to 13 sensoria.....*luridis* Hottes and Frison p. 200
- 23. Abdomen black, brown, or reddish, not green or yellow.....24
- Abdomen green or yellow or some shade of these two colors.....27
- 24. Terminal filament subequal to length of third antennal segment, always much longer than one-half of the third segment.....25
- Terminal filament subequal to one-half length of third antennal segment27

25. Cornicles almost equal to, or longer than, twice length of hind tarsi exclusive of claws; color bluish or black or greenish black. 26
- Cornicles shorter, at most scarcely more, than one and one-half times length of hind tarsi exclusive of claws; color of abdomen pruinose reddish brown. *cephalanthi* Thomas p. 185
26. Fourth antennal segment with 3 to 16 sensoria; on *Gerardia*.
- Fourth antennal segment with less than 8 sensoria, usually 1 to 3; on a great variety of plants. *rumicis* var. *gerardiae* (Thomas) p. 217
- Fourth antennal segment with less than 8 sensoria, usually 1 to 3; on a great variety of plants. *rumicis* Linnaeus p. 215
27. Third antennal segment with 20 or more sensoria. 28
- Third antennal segment with less than 20 sensoria. 32
28. Fourth antennal segment with more than 5 sensoria. 29
- Fourth antennal segment with less than 4 sensoria. 31
29. Terminal filament of sixth antennal segment about twice as long as fifth antennal segment, ground color of abdomen golden yellow. *luridis* Hottes and Frison p. 200
- Terminal filament of sixth antennal segment only slightly longer than fifth antennal segment, ground color of abdomen yellow or greenish. 30
30. Secondary sensoria conspicuously large, those on fourth antennal segment mostly larger than primary sensorium on fifth; abdomen essentially dark brown or almost black; on *Senecio*.
- Secondary sensoria mostly small, those on fourth usually distinctly smaller than primary sensorium on fifth; abdomen essentially dark green; on *Zizia* and other umbelliferous plants. *nyctalis* Hottes and Frison p. 206
31. On *Asclepias* and *Apocynum* sp.; abdomen yellow with lateral and caudal black spots; third antennal segment with 10-20 sensoria, fourth without sensoria; cornicles not more than $1\frac{1}{2}$ times length of cauda and subequal to, or longer than, fourth antennal segment; sixth antennal segment with terminal filament 2 or 3 times length of base. *asclepiadis* Fitch p. 181
- On *Circium*; abdomen essentially moderately dark green; with lateral and caudal blackish spots; third antennal segment with 15-25 sensoria, fourth without; cornicles subequal to, or considerably more than, $1\frac{1}{2}$ times cauda, and slightly longer than fourth antennal segment; sixth antennal segment with terminal filament about twice length of base. *carduella* Walsh p. 183
- On *Pastinaca*; abdomen yellow with large lateral blackish patches; third antennal segment with 35-50 sensoria, fourth usually without sensoria but occasionally with one or two; cornicles always distinctly longer than $1\frac{1}{2}$ times length of cauda, and always longer than fourth antennal segment; sixth antennal segment with terminal filament about three times base. *decepta* Hottes and Frison p. 192
- On *Cornus* or *Helianthus*; abdomen dark green with dark brown lateral and caudal patches; third antennal segment with 25-35 sensoria, fourth normally without sensoria, rarely with one or two; cornicles subequal to, or longer than, $1\frac{1}{2}$ times length of cauda and much longer than fourth antennal segment; sixth antennal segment with terminal filament about twice length of base. *helianthi* Monell p. 196
32. Hind tarsi entirely dark brown or black; on corn. *maidis* Fitch p. 205
- Hind tarsi pallid or yellow with the apices dark brown and contrasting with the basal portion; not on corn. 33
33. Fourth antennal segment usually with three or more sensoria, rare specimens without sensoria on fourth. 34
- Fourth antennal segment normally without sensoria, rarely with one or two sensoria. 35
34. On gooseberry and currant (*Ribes*). *sanborni* Patch p. 218
- On *Rhamnus* and a large variety of summer hosts.
- *rhamni* Fonscolombe p. 214

35. Abdomen yellowish green; on <i>Asclepias</i> and <i>Apocynum</i> sp.....	asclepiadis Fitch	p. 181
— Abdomen pea green; on <i>Cirsium</i>	carduella Walsh	p. 183
36. Hind tibiae pallid or yellowish with apex brown, contrasting with basal portion		44
— Hind tibiae entirely black or blackish brown, or with the basal half and the apex dark brown and the middle portion lighter.....		37
37. Ground color of abdomen yellow or green.....		38
— Ground color of abdomen red, purplish, or reddish brown.....		40
38. Terminal filament of sixth antennal segment four or more times the length of basal portion of segment.....	ageratoidis Oestlund	p. 181
	and	
	coreopsidis (Thomas)	p. 188
— Terminal filament much less than three times the length of basal portion of segment, usually about twice as long.....		39
39. Cauda short and conical (Fig. 201), not constricted near middle; on roots and crowns of corn and other plants.....	maidi-radicis Forbes	p. 202
— Cauda longer (Fig. 197), constricted near middle; on leaves and stalks of corn and other plants.....	maidis Fitch	p. 205
40. Cauda short, not constricted near middle (Figs. 192, 201).....		41
— Cauda longer, distinctly constricted near middle (Fig. 197).....		43
41. Abdomen with four pairs of large prominent lateral tubercles anterior to cornicles; fourth and fifth antennal segments with secondary sensoria, usually 3 to 5 on each....	feminea Hottes	p. 193
— Abdomen at the most with only one or two pairs of large lateral tubercles anterior to cornicles; fourth and fifth antennal segments normally without secondary sensoria.....		42
42. Cornicles longer than terminal filament of sixth antennal segment; on <i>Prunus</i>	chetansapa Hottes and Frison	p. 186
— Cornicles very much shorter than terminal filament of sixth antennal segment, subequal to half its length; on <i>Psedera</i>	folsomii Davis	p. 193
43. Cornicles subequal in length to terminal filament of sixth antennal segment; on grape.....	illinoisensis Shimer	p. 198
— Cornicles very much shorter than terminal filament of sixth antennal segment, subequal to half its length; on <i>Cephalanthus</i> and <i>Impatiens</i>	cephalanthi Thomas	p. 185
44. Abdomen blue, blackish, brown or reddish-brown.....		45
— Abdomen green or yellow.....		51
45. Cornicles very much shorter than third antennal segment.....		46
— Cornicles subequal to, or longer than, third antennal segment.....		49
46. Cauda short, broad, and rounded (Fig. 202), not constricted near middle; on <i>Cornus</i>		47
— Cauda longer and more slender (Fig. 200), slightly constricted near middle		48
47. Cornicles slightly shorter than cauda; abdomen with three single pairs and one double pair of large lateral tubercles anterior to cornicles (Fig. 309).....	caliginosa Hottes and Frison	p. 182
— Cornicles longer than cauda; abdomen with less than five pairs of lateral tubercles anterior to cornicles.....	cornifoliae Fitch	p. 189
48. Fourth antennal segment usually with one to four sensoria; a pruinose reddish-brown species on <i>Cephalanthus</i> or <i>Impatiens</i>	cephalanthi Thomas	p. 185
— Fourth antennal segment without sensoria; a pulverulent bluish-green species on <i>Euphorbia</i>	pulchella Hottes and Frison	p. 212
49. Distance between first and second fork of media less than twice distance between second fork and edge of wing measured along vein medial 1.....		50
— Distance between first and second fork of media more than twice distance between second fork and edge of wing measured along vein medial 1.....	forbesi Weed	p. 191

50. Sixth antennal segment (base plus filament) longer than cornicles: species on *Liatris*.....*funesta* Hottes and Frison p. 194
- Sixth antennal segment subequal to cornicles; species on *Laburnum* and other legumes.....*laburni* Kaltenbach p. 199
51. Base of sixth antennal segment shorter than fifth, and also fourth, antennal segment.....53
- Base of sixth antennal segment subequal to, or slightly longer than, fifth, and usually also fourth, antennal segment.....52
52. Cornicle nearly twice or more than twice, length of cauda; species on leaves and stems of *Eupatorium* and allied Compositae.....*vernoniae* Thomas p. 222
- Cornicle distinctly less than twice as long as cauda; species on roots and crowns of corn and other plants.....*maidi-radici* Forbes p. 202
53. Cornicles longer than cauda.....55
- Cornicles equal to or slightly shorter than cauda.....54
54. Fourth antennal segment with secondary sensoria, usually numbering 3-5; on gooseberry.....*sanborni* Patch p. 218
- Fourth antennal segment lacking secondary sensoria; on *Liatris*.....*zilora* Hottes and Frison p. 224
55. Cornicle subequal to, or greater than, twice length of fourth antennal segment.....56
- Cornicle distinctly shorter than twice length of fourth antennal segment.....57
56. Cauda (Fig. 194) triangular in outline, not markedly constricted near middle; small species with a bright yellowish green abdomen; on *Eupatorium* and *Vernonia*.....*vernoniae* Thomas p. 222
- Cauda (Fig. 197) markedly constricted near middle; species with a green abdomen; on *Salix*.....*saliceti* Kaltenbach p. 217
57. Fourth antennal segment usually with sensoria numbering from one to six, occasionally without, in which case the third segment usually has 8 or more sensoria.....58
- Fourth antennal segment normally without sensoria, a rare specimen with one or two; third antennal segment usually with less than 7 sensoria.....61
58. On gooseberry and currant (*Ribes*); cornicles shorter than third antennal segment; third antennal segment with 6-10 sensoria, often not in a straight row; fourth with 2-6 sensoria, either in a row or grouped.....*sanborni* Patch p. 218
- On *Monarda*; cornicles shorter than third antennal segment; third antennal segment with 4-6 sensoria, always in a row; fourth with 1-3, usually 2; cauda with portion beyond constriction relatively short and broad (Fig. 190).....*monardae* Oestlund p. 205
- On hosts other than *Ribes* or *Monarda*.....59
59. Cornicles usually as long as third antennal segment, only rarely distinctly shorter; third antennal segment with 6-10 sensoria, fourth with 1-4, but usually 2.....60
- Cornicles always shorter than third antennal segment; third antennal segment with 6-16 sensoria, fourth with 0-8, fifth with 0-4; overwintering on *Rhamnus* and migrating to many and varied summer hosts.....*ramni* Fonscolombe p. 214
60. On apple and related species (*Pyrus* or *Crataegus*); hind tibiae of oviparous females slender, with few sensoria; males apterous.....*pomi* DeGeer p. 210
- On *Spiraea* and many other summer hosts; hind tibiae of oviparous females swollen, thickly studded with sensoria; males alate.....*spiraecola* Patch p. 220
61. Cauda spatulate (Fig. 193) or triangular in outline (Fig. 194), not constricted near middle.....62
- Cauda constricted near middle (Fig. 197).....63

62. Cauda spatulate (Fig. 193), apex rounded; third antennal segment subequal in length to terminal filament, small species curling leaves of blackberry.....*rubicola* Oestlund p. 215
- Cauda triangular (Fig. 194), apex pointed; third antennal segment distinctly shorter than terminal filament, a medium-sized species curling leaves of chokecherry.....*cerasifoliae* Fitch p. 186
63. On *Oenothera*.....*oestlundii* Gillette p. 208
- On cotton, cucurbits, and many other plants.....*gossypii* Glover p. 195

APHIS AGERATOIDIS OESTLUND

Aphis ageratoidis Oestlund, Fourteenth Annual Report of the State Geologist of Minnesota, March, 1886, p. 38.

This species is recorded now from Illinois for the first time. When Oestlund described this species he commented on its being very closely allied to *Aphis frondosae* Oestlund. The latter has since been made a synonym of *Aphis coreopsidis* (Thomas). Although recognizing the difficulty of separating *Aphis ageratoidis* from *A. coreopsidis*, we prefer for the present to recognize the two forms as distinct. The sexual forms have not been described.

Data associated with our viviparous specimens placed as this species are as follows: Catlin (Sept. 27, Oct. 6), East Dubuque (June 26), Havana (June 21), Herod (May 29), Mt. Carroll (June 25), Oakwood (Sept. 17), Oregon (June 28), Urbana (May 16, July 10), 1928; Kappa (Sept. 9), Oakwood (Oct. 17), 1929; Oakwood (Oct. 22), 1930. Collected on *Blephilia hirsuta*, *Brickellia* sp., *Eupatorium urticaefolium*, *Eupatorium* sp., *Nepeta cataria*, and *Vernonia* sp.

APHIS ASCLEPIADIS FITCH

Aphis asclepiadis Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 65.

The species which we are considering under the above name has been previously reported from Illinois by Gillette (1910) and by Davis (1910a). The *Aphis apocynii* Koch listed by Thomas (1879) from Wisconsin, as shown by a slide (2765), of Thomas, is undoubtedly this species. It is quite generally distributed in Illinois on milkweed.

Data associated with our alate and apterous viviparous specimens, all collected on *Asclepias* sp. or *Apocynum* sp., are as follows: Galena (June 25), Kankakee (June 29), 1928; Beach (July 13), Bloomington (July 5), Edwardsville (Sept. 11), Jerseyville (June 25), Rock Island (July 7), Seymour (June 13), 1929.

APHIS BAKERI COWEN

FIG. 99

Aphis bakeri Cowen, Agricultural Experiment Station of Colorado State Agricultural College, Bulletin No. 31, Technical Series No. 1, May, 1895, p. 118.

The short-beaked clover aphid was first reported as occurring in Illinois by Davis (1908c) who reported it as a common species throughout the state on red clover. This species has been shown by Gillette

and Taylor (1908) to spend the winter in the egg stage chiefly upon apple, pear, *Crataegus*, etc., and the summer upon clover. Gillette (1908b) has given detailed descriptions of all the various forms. In Colorado *A. bakeri* is sometimes a pest on apples.

Data associated with our alate and apterous viviparous specimens, all collected on *Trifolium pratense*, are as follows: Normal (May 14), 1884; Champaign (Nov.), 1885; Bement (June 17), Cairo (June 2), East Peoria (July 22), Galena (June 25), LeRoy (June 20), Morgan County (June 19), Muncie (Oct. 6), Oakwood (July 18), Oregon (June 28), St. Anne (July 15), 1928; Cairo (June 22), Edwardsville (Sept. 11), 1929.

APHIS CALIGINOSA new species

FIGS. 140, 202, 284, 309

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.60. Head, thorax, and cornicles black. Abdomen with base and apex blackish, intermediate area somewhat light brown. First and second antennal segments concolorous with head; apex of fifth and all of sixth segments blackish; remainder of antennae light brownish. Eyes black. Coxae and trochanters concolorous with venter of body; fore femora yellowish brown, middle and hind femora blackish except for extreme brownish bases; tibiae of all legs essentially yellowish brown with apices black for a distance about equal to length of tarsi; tarsi of all legs black. Beak brown, with extreme tip blackish. Costal margin of front wing yellowish brown near base; remainder of veins dark brown.

Head and appendages.—Average width of head across eyes, .39. Antennal segments with comparative lengths as follows: III—.20 to .29, average .25; IV—.13 to .16, average .15; V—.11 to .16, average .13; VI—.07 to .11, average .09 plus .14 to .23, average .18. Secondary sensoria (Fig. 284) limited to the third segment, numbering from 5 to 9, averaging 6, arranged in a more or less straight row, or in two sub-parallel rows. Sensoria usually closer together towards apex of segment, leaving the basal third of the segment free from sensoria. Primary sensorium of the sixth antennal segment subequal to that of fifth, with a group of marginal sensoria. All antennal segments beyond second distinctly imbricated. Beak varying in length, reaching either not quite to, or a little beyond, the mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of large, flat cone-shaped, lateral tubercles with unusually large bases. Fore wings with stigma rather bluntly pointed at apex. Cell R: shallow, not much, if any, wider than stigma. Second fork of media closer to margin of the wing than to the first fork, although not constant in position; in some cases entirely absent. Middle and hind femora with from three to four sensoria near their base. Hairs on tibiae fine and about as long as the width of the segment.

Abdomen.—Abdomen (Fig. 309) with five pairs of lateral tubercles anterior to the cornicles, the first segment apparently bearing two pairs. The posterior three pairs are small, usually difficult to find. Segment posterior to cornicles with a pair of unusually large lateral tubercles, which are approximately the same size and shape as those on prothorax. Cornicles (Fig. 140) averaging .10 in length, shorter than cauda, straight, without an apical flange, imbricated throughout, and very slightly constricted at, or just before, apex. Cauda (Fig. 202) averaging .12 in length, not constricted, larger than cornicles, with from 7 to 8 pairs of lateral hairs, in addition to a dense covering of small spine-like setae. Anal plate well developed, a little longer than usual, and clothed with short spine-like setae in addition to fringe of numerous long hairs.

PUPA

Color.—Head and thorax more greenish than alate form; dorsum of abdomen with two longitudinal pruinose areas and a transverse pruinose patch posterior to cornicles.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, .127. Color as in alate viviparous female, except that abdomen is mottled, due to green embryos showing through integument, and the fore legs are darker in color.

Head and appendages.—Average width of head across eyes, .39. Antennal segments with comparative lengths as follows: III—.17 to .19, average .18; IV—.09 to .11, average .10; V—.09 to .11, average .10; VI—.09 to .10, average .09 plus .10 to .17, average .14. Secondary sensoria absent. Antennae imbricated and with scattered, short, fine hairs. Beak extending to, or slightly beyond, metathoracic coxae.

Thorax and appendages.—Surface of thorax reticulate. Prothorax with large lateral tubercles.

Abdomen.—Surface of abdomen imbricated or imperfectly reticulate. Lateral tubercles similar in number and position to those of alate viviparous female, but smaller, the anterior pair on the first segment being small and pointed, much smaller than those of the second, third, and four segments. Tubercles on segment posterior to cornicles, the same shape and size as those of alate viviparous female. Cornicles .10 in length, in shape similar to those of the alate viviparous female. Cauda .12 in length, similar to that of the alate viviparous female.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Similar in size, color and structure to virgogenia, but differing in the following details. Average width of head across eyes, .39. Antennae five-segmented, the comparative lengths being as follows: III—.21 to .26, average .24; IV—.10 to .11, average .10; V—.09 to .10, average .09 plus .09 to .11, average .10. Lateral tubercles of prothorax and abdomen slightly smaller, those of second, third, and fourth abdominal segments being especially small and flat.

Holotype.—Alate viviparous female; Starved Rock State Park, Illinois, June 13, 1928, on *Cornus* sp., (Frison and Hottes). On slide with paratypic specimens of alate and apterous viviparous females, pupae and nymphs. Slide No. 3966. *Morphotype.*—Apterous viviparous female (virgogenia); same data as holotype. Slide No. 3968. *Morphotype.*—Apterous viviparous female (fundatrix); Starved Rock State Park, Illinois, May 13, 1930, on *Cornus* sp., (Frison and Ross). Slide No. 10481. *Paratypes.*—Seventy-one slides, containing alate and apterous viviparous females, pupae and nymphs, collected in Illinois on species of *Cornus*, by T. H. Frison, F. C. Hottes, H. H. Ross and Marten. The dates and localities are as follows: Urbana (May 1, 12 and 15) (Acc. Nos. 19944, 19945, and 19946), 1894; Herod (May 29) and Starved Rock State Park (June 13), 1928; Hardin (June 25), Herod (June 21) and Macomb (May 4), 1929; and Starved Rock State Park (May 13), 1930. Slides Nos. 3964-3965, 3967, 3969-3970, 3984-3986, 10482-10524 and others unnumbered.

This species may be collected on the more terminal branches of its host. In at least one case it was attended by the ant, *Crematogaster lincolata* Say, which had constructed an aphid shed over the aphids. This species is closely allied to *Aphis maidi-radici* Forbes from which it may be separated by its brownish color, and the much more strongly developed lateral tubercles posterior to the cornicles.

APHIS CARDUELLA WALSH

FIGS. 132, 195, 279

Aphis carduella Walsh, Proceedings of the Entomological Society of Philadelphia, Vol. I, December, 1862, p. 300.

Although this species seems to be common in Illinois on *Cirsium lanceolatum*, Oestlund (1887) is the only writer known to us who has

noted its occurrence anywhere since the original description was published. Our specimens agree well with the meagre original description except for minor details and statement regarding color. We are of the opinion that in this last mentioned respect Walsh was misled by dead material. We are informed by Oestlund that his description of this species is based upon a male, thus accounting for the difficulty at first encountered in connecting our material with his description and our interpretation of the species described by Walsh. Specimens identified as *carduella* by Oestlund are similar to those we are considering as this species. The oviparous female has not been described.

Since the original description is very meagre and the types are lost, Slide No. 9461 in the Survey collection has been selected as the *neotypic* slide and redescriptions are given of the alate and apterous viviparous females.

Data associated with this neotypic slide are as follows: Alate viviparous female; Sparta, Illinois, June 24, 1929, on *Cirsium lanceolatum*. (Frison and Hottes). On slide with alate viviparous female.

All of our Illinois material has been collected on *Cirsium lanceolatum*. Our data are as follows: Bloomington (July 5), Farmer City (July 5), Mitchell (June 25), Nameoki (June 25), Rock Island (July 7), St. Clair County (June 24), St. Joseph (June 29), Sparta (June 24), Urbana (August 27), and Woodford (July 5), 1929.

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.31. Head and thorax dark greenish brown. Abdomen green with five lateral brown spots, those posterior to the cornicles being the largest. Cornicles, cauda, and anal plate dark brown. Antennae concolorous with, or slightly lighter than, head. Legs with coxae dark brown, trochanters luteous; femora luteous at base with apical two-thirds brown, middle and hind femora dark brown; tibiae luteous with enlarged apical portion dark brown; tarsi dark brown. Forewings with stigma brownish, veins light brown, posterior margin of wing in vicinity of anal vein brownish. Beak brownish, its apical portion darkest.

Head and appendages.—Average width of head across eyes, .38. Antennal segments with comparative lengths as follows: III—.17 to .29, average .24; IV—.11 to .16, average .14; V—.10 to .14, average .12; VI—.07 to .10, average .09 plus .17 to .23, average .18. Secondary sensoria (Fig. 279) typically limited to third antennal segment, numbering from 18 to 25, averaging 20, mostly confined to one side of segment, very irregularly arranged and varying greatly in size; some specimens differ in having from 1 to 4 secondary sensoria on fourth antennal segment. Primary sensorium on sixth antennal segment with a group of small marginal sensoria to one side of it. Antennae imbricated and with a few short hairs. Beak extending to middle of metathoracic coxae.

Thorax and appendages.—Prothorax with a pair of small lateral tubercles. Second fork of media closer to margin of wing than to first fork. Stigma rather bluntly pointed.

Abdomen.—First abdominal segment and segment posterior to cornicles with a pair of small lateral tubercles. Cornicles (Fig. 132) straight, averaging .19 in length, without a distinct flange at apex, and imbricated. Cauda (Fig. 195) averaging .12 in length, constricted at middle, with from five to six pairs of lateral hairs, the terminal pairs incurved.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.35. Body (head, thorax, and abdomen) with anterior part brownish green shading posteriorly to dark green. Cornicles, cauda, anal plate, and patches

posterior to cornicles, brown. Basal half of antennae concolorous with head, extreme apex of third segment, apical third of fourth and fifth, and sixth almost entirely, brown or brownish infusate. Legs patterned as in alate viviparous female, but lighter in color. Beak as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .40. Antennal segments with comparative lengths as follows: III—.21 to .29, average .25; IV—.09 to .16, average .13; V—.09 to .14, average .11; VI—.06 to .09, average .07 plus .16 to .21, average .18. Secondary sensoria absent, antennae imbricated, and bearing a few fine hairs. Beak extending to middle of metathoracic coxae.

Thorax and appendages.—Prothorax with a pair of lateral tubercles.

Abdomen.—First abdominal segment and segment posterior to cornicles with a pair of lateral tubercles. Cornicles averaging .20 in length, shaped as in the alate viviparous female. Cauda averaging .15 in length, constricted near the middle, and with from five to six pairs of lateral hairs.

Morphotype.—Apterous viviparous female; Urbana, Illinois, August 27, 1929, on *Cirsium lanceolatum*, (H. H. Ross). Slide No. 9462.

This species differs from *Aphis rumicis* Linn. by its color and by the distribution of secondary sensoria. Two other species of this genus, *rumicis* Linn. and *cardui* Linn., have so far been found on *Cirsium* in Illinois in addition to this species. For other distinguishing characters see the key to species belonging to this genus.

APHIS CARDUI LINNAEUS

Aphis cardui Linnaeus, Systema Naturae, Editio Decima, 1758, p. 452.

This species has not been recorded from Illinois under this name, but probably the record of *A. prunifoliae* Fitch from Niles Center, Illinois, by Davis (1910e) and the indefinite record of *A. pruni* Koch by Thomas (1879) refer to this species. Thistles attacked by this species in summer are usually heavily infested, but according to our experiences infested plants are scarce. Patch (1914b) calls attention to the fact that in Europe this species migrates between plum and thistle.

Data associated with our viviparous specimens, all collected on *Cirsium* sp., are as follows: Galena (June 25), Morton (July 22), Rossville (July 15), 1928; Oakwood (Nov. 9), Oregon (July 9), 1929.

APHIS CEPHALANTHI THOMAS

Aphis cephalanthi Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 11.

Aphis impatientis Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 12. *New synonymy.*

This species was described as new from specimens collected at Carbondale, Illinois, and was again reported from the state by Davis (1910e). Although the typic specimens of *A. cephalanthi* have not been recovered, there is no doubt regarding the aphid that Thomas described under this name. *A. impatientis* Thomas was described at the same time as *cephalanthi*, but the latter has page priority. Typic specimens of *impatientis* prove that this species is a synonym of *cephalanthi*. Our field collecting shows that this species has the buttonbush as its overwintering host and the touch-me-not as its summer host. On button-

bush this species is found on the terminal twigs and leaves and on touch-me-not on the under sides of the leaves.

Data associated with our viviparous specimens, all collected on *Cephalanthus occidentalis* or *Impatiens* sp., are as follows: Herod (Oct. 12), 1928; Cairo (June 21), Collinsville (Sept. 11), Herod (Sept. 27), Mahomet (Aug. 17), Starved Rock State Park (Aug. 14), 1929; Homer Park (June 17), 1930.

Neotypic slide.—Since this species was originally described from Carbondale, Illinois, by Thomas, and the types are lost, a slide in the Survey collection is selected as the *neotype*. The data associated with the neotypic slide are as follows: Cairo, Illinois, June 21, 1929, on *Cephalanthus* sp., collected by T. H. Frison and F. C. Hottes. Slide 6373.

Data associated with the cotypic slide (8778) of *Aphis impatientis* Thomas are as follows: Carbondale, Illinois, August, on *Impatiens fulva*.

APHIS CERASIFOLIAE FITCH

Aphis cerasifoliae Fitch, Transactions of the New York State Agricultural Society, Vol. XIV, 1854 (printed 1855), p. 835.

The choke cherry aphid was first reported from Illinois by Davis (1910e). This species curls the leaves of the choke cherry, and certain other species of *Prunus* used in landscaping, so badly that it often disfigures them. We have no record of this species occurring south of the central portion of the state. The alate and apterous forms have been described in full by Patch (1914b) and Swain (1919). The sexual forms have apparently not been described.

Our viviparous specimens in the Survey collection, all collected on *Prunus virginiana* or *Prunus* sp., bear the following data: Normal (May 27), 1886; Galena (July 10), Macomb (May 3, 4), Richmond (July 12), Waukegan (July 13), 1929.

APHIS CHETANSAPA new species

FIGS. 142, 193, 280

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.10. Head and thorax dark blackish brown; abdomen purple-lake with six pairs of lateral black patches anterior to cornicles, with large black patches near base of, and between, cornicles, which in many specimens connect and form a transverse black band; and posterior to this band, with two other transverse bands in some specimens, successively narrower, making a total of three. Cauda and anal plate black, cornicles dark brown. Eyes reddish-brown. Antennae concolorous with the head or only slightly lighter. Legs black, except front femora which are yellowish-brown, slightly darker at apex. Beak at base concolorous with head, apex black, intermediate portion yellowish. Wings hyaline, with the following parts greyish-brown: stigma, costa, apical half of subcosta, veins, and the posterior margin of the wing in the vicinity of the anal vein; veins with a suggestion of a border.

Head and appendages.—Average width of head across eyes, .37. Antennal segments with the following comparative lengths: III—.23 to .29, average .25; IV—.14 to .17, average .16; V—.13 to .17, average .14; VI—.10 to .13, average .11 plus .16 to .19, average .17. Secondary sensoria (Fig. 280) confined to the third antennal segment, arranged in a straight row, numbering from 4 to 8, averaging 6. Primary sensorium of sixth antennal segment small, slightly smaller than that on fifth, the marginal sensoria grouped to one side of it. All segments of flagellum distinctly imbricated.

Beak variable in length, usually extending only to mesothoracic coxae, but sometimes extending past the metathoracic coxae.

Thorax and appendages.—Prothorax with a large lateral tubercle on each side. Second fork of media usually present and very close to margin of wing, in one or two cases entirely lacking. Femora with moderately numerous, erect, fine hairs. Tibiae clothed with long, declinate hairs, increasing in length and numbers from base to apex, thickest on hind tarsi; bases of hairs transparent yellow, giving the tarsi a minute speckled appearance.

Abdomen.—Cornicles (Fig. 142), straight, without flange, imbricated, length averaging .22. First segment with a pair of small, tooth-like, lateral tubercles. Segment posterior to cornicles with a pair of large lateral tubercles. Cauda (Fig. 193), averaging .08 in length, with about five hairs on each side, the terminal hairs strongly incurved. Anal plate normal in shape.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.22. Head yellowish-brown to reddish-brown, thorax and abdomen lighter, yellowish-brown to yellowish-red. Antennae with the two basal segments concolorous with head, base of flagellum much lighter but gradually becoming darker towards apex. Prothorax, lateral pleural areas of thorax, coxae, legs except front femora and base of middle and hind femora, small patches on dorsum posterior to cornicle, anal plate, and cauda, light or dark reddish-brown; front femora sometimes concolorous with rest of legs, sometimes light yellowish-brown; middle and hind femora with base yellowish-brown. Cornicles blackish-brown. Beak as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .34. Antennal segments with comparative lengths as follows: III—.24 to .43, average .32; IV—.10 to .26, average .17; V—.14 to .17, average .16; VI—.09 to .13, average .11 plus .14 to .20, average .16. Secondary sensoria absent; antennae imbricated. Primary sensorium present on fifth and sixth antennal segments, that on sixth small, with six marginal sensoria grouped to one side of it.

Thorax and appendages.—Prothorax with a large, tooth-like, lateral tubercle on each side. Legs similar to legs of alate viviparous female in structure.

Abdomen.—First segment and segment posterior to the cornicles each with a pair of lateral tubercles subequal to or smaller than those on prothorax. Cornicles similar to those of alate viviparous female, .31 long. Cauda not constricted, .11 long, with 4 or 5 pairs of lateral hairs.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Size and general color.—Length from vertex to tip of anal plate, 1.34. Head, thorax, antennae, legs, cornicles, and cauda, black. Abdomen and posterior portion of thorax pinkish brown.

Head and appendages.—Average width of head across eyes, .43. Antennae five segmented, comparative lengths as follows: III—.36 to .40, average .38; IV—.11 to .13, average .12; V—.11 to .13, average .11 plus .09 to .11, average .10.

Otherwise similar to virgogenia.

Holotype.—Alate viviparous female; Oregon, Illinois, June 28, 1928, on *Pyrus* sp., (Frison, Hottes, and Ross). On slide with alate viviparous female, apterous viviparous females and nymphs. Slide No. 10530. *Morphotype.*—Apterous viviparous female (virgogenia); same data as holotype. On slide with alate and apterous viviparous females and nymphs. Slide No. 10531. *Morphotype.*—Apterous viviparous female (fundatrix); Oregon, Illinois, May 15, 1930, on *Prunus* sp., (Frison and Ross). Slide No. 10532. *Paratypes.*—Eighty-five slides of alate and apterous viviparous females, pupae and nymphs, collected in Illinois by T. H. Frison, F. C. Hottes, and H. H. Ross on *Pyrus* and *Prunus* sp. The localities and dates are: Galena (June 26), and Oregon (June 28), 1928; Oregon (July 11) and Oakwood (July 22), 1929; and Oregon (May 15), 1930. Slides Nos. 10533-10569, 10579-10597 and others unnumbered.

This species causes the terminal leaves of the host to curl very tightly. In life it does not suggest in habit or form any other *Aphis*. Mounted specimens resemble *Aphis feminea* in color, but the alate viviparous females differ from *feminea* in having no sensoria on the fourth and fifth antennal segments and in having fewer sensoria on the third antennal segment.

APHIS COREOPSIDIS (THOMAS)

Siphonophora coreopsidis Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 4, 5 figures.

This species is quite generally distributed over Illinois and has been recorded from the state by Davis (1910e) in addition to being described on the basis of Illinois material. The discovery of the sexual forms in fall on black gum indicates that this may be the over-wintering host of this species in southern Illinois. From its primary host it migrates in early summer to *Eupatorium* and *Bidens*. On black gum it shows a decided preference for the stems and leaves of new shoots, often completely encircling the apical portions of the stems for several inches. It occurs on the undersides of the leaves and the flower stalks of its summer hosts. Descriptions of the previously undescribed sexual forms are here presented.

Cotypes of this species were found preserved in vials of the Thomas Collection. These have been mounted in damar balsam on Slide No. 7716. Data associated with this slide are: St. Louis, Missouri, October on *Coreopsis aristosa*, collected by T. Pergande. Dr. Oestlund has determined slides of this species as *A. frondosae* Oestlund, and Davis (1910) has definitely placed this name in the synonymy of *coreopsidis*.

Data associated with our viviparous specimens are as follows: Carbonale (June 4), Elizabethtown (Oct. 12), Herod (May 29), Metropolis (May 31, June 31), Muncie (Oct. 6), 1928; Decatur (Sept. 21), Fern Cliff (Sept. 27), Grayville (June 19), Herod (Sept. 27), Kappa (Sept. 22), Oakwood (Oct. 13, 17), Waukegan (Aug. 29), 1929; Fairmount (Sept. 28), 1930. Collected on *Eupatorium urticaefolium*, *Bidens vulgata*, and *Nyssa sylvatica*. Sexual forms taken only on the latter host at Fern Cliff on September 27, 1929.

ALATE MALE

Length, 1.00. Head and thorax dark greenish brown, abdomen dark green; cornicles and cauda brownish, antennae brown. Legs greenish brown with apical portions of femora and tibiae darker; fore legs lightest in color. Stigma greenish brown, veins brown. Average width of head across eyes, .41. Comparative lengths of antennal segments as follows: III—.23; IV—.27; V—.21; VI—.09 plus .46. Secondary sensoria on third and fourth antennal segments scattered, on fifth arranged in an irregular row; numbering as follows: III—18; IV—18; V—6. Beak reaching beyond mesothoracic coxae. Second fork of media distinctly closer to margin of wing than to first fork. Cornicles .21 long, straight, entire surface imbricated. Cauda .11 long, with about 5 hairs on a side.

APTEROUS OVIPAROUS FEMALE

Length, 1.16. Color yellowish or yellowish green, with flagellum of antennae except base brown; apices of cornicles and more or less of tibiae and tarsi, infusate with brown. Average width of head across eyes, .29. Comparative lengths of antennal segments as follows: III—.26; IV—.24; V—.26; VI—.10 plus .50. All segments imbricated. Cornicles .30 long. Cauda about .10 long with about 5 lateral hairs. Hind tibiae decidedly swollen, with about 95 sensoria.

Allotype.—Alate male; Slide No. 8325, Fern Cliff, Illinois, September 27, 1929, on *Nyssa sylvatica*, (Frison and Hottes). On slide with alate viviparous female. *Morphotype*.—Apterous oviparous female; Slide No. 8324, same data as allotype. On slide with alate viviparous females.

APHIS CORNIFOLIAE FITCH

FIGS. 133, 271

Aphis cornifoliae Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History. January 14, 1851, p. 65.

Slides of our specimens have been compared with two slides of *A. cornifoliae*, which are undoubtedly the types, kindly loaned to us by the U. S. National Museum. According to Mason, these slides are associated with notes No. 846 and 9020 of Pergande which indicate the specimens were originally mounted by Fitch on card points and then remounted on slides. The number assigned to this species in the original description is 846. Since this species has never been adequately described, or even authentically recorded, since the brief original description of the apterous females, a more detailed description of the apterous form is given here as well as a description of the previously undescribed alate viviparous female.

Aphis cornifoliae Fitch has been mentioned twice in literature by Oestlund (1885, 1887), and the name again appears in an article by Davis (1910e), who does not, however, record it from Illinois but refers certain references to *helianthi* Monell. In 1910, also, Gillette records this species, figures it, and gives notes on its life history. All of these records refer to the true *helianthi* of Monell. Oestlund's description was based upon a male.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.02. Color throughout almost identical with color of alate viviparous female, except that sometimes the thorax may be greenish, and the legs and antennae may be lighter.

Head and appendages.—Average width of head across eyes, .36. Antennal segments with the following comparative lengths: III—.24 to .33, average .27; IV—.13 to .17, average .15; V—.10 to .16, average .13; VI—.09 to .11, average .10 plus .23 to .31, average .28. Antennae without secondary sensoria or hair, flagellum imbricated.

Thorax and abdomen.—Dorsal surface of thorax and abdomen imbricated or reticulated. Lateral tubercles as in alate viviparous female. Cornicles averaging .21 in length, similar to, but more strongly outwardly curved than, the cornicles of the alate viviparous form. Cauda and anal plate as in the alate viviparous female.

The abdomens of the apterous viviparous females appear to be free from embryos, and this, together with the extremely small size of these specimens, suggests that they may be dimorphic forms.

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.08. Head, thorax and abdomen uniform dark brown or brownish-black. Cornicles, cauda, and anal plate dark brown, extreme base of cauda lighter. First and second antennal segments concolorous with head, remaining segments brownish, sometimes slightly darker towards apex. Femora brown except for yellowish-brown areas near the base, the posterior pair darkest;

tibia light yellowish-brown, darker at the apex; tarsi brown. Stigma and veins dusky brown, posterior margin and wing in vicinity of anal vein dusky. Beak dark brown.

Head and appendages.—Average width of head across eyes .36. Antennal segments with comparative lengths as follows: III—.24 to .29, average .28; IV—.14 to .17, average .16; V—.13 to .14, average .14; VI—.09 to .11, average .10 plus .23 to .34, average .29. Secondary sensoria (Fig. 271) confined to third and fourth antennal segments, sensoria on the third arranged in an irregular row, usually numbering from five to eight, average seven, one apparently aberrant specimen with fifteen sensoria; fourth segment with from 0 to three sensoria, usually two; sensoria very difficult to distinguish, due to dark color of antennae. Beak barely reaching to mesothoracic coxae. Primary sensorium on sixth antennal segment small, marginal sensoria grouped to one side of it.

Thorax and appendages.—Prothorax with a pair of lateral tubercles. Stigma of fore wings comparatively narrow, and sharply pointed at apex; radial sector little bowed; second fork of media closer to margin of wing than to the first fork.

Abdomen.—A pair of lateral tubercles on first abdominal segment, and on segment posterior to cornicles. Cornicles (Fig. 133) longer than cauda, length .16; imbricated, with narrow flange at the apex, of almost uniform width throughout, except sometimes very slightly swollen near apex and somewhat outwardly curved. Cauda not constricted, length .11, bluntly rounded at apex, with four pairs of lateral hairs. Anal plate normal in shape. Body sparsely covered with fine hairs.

Morphotype.—Alate viviparous female; Pekin, Illinois, June 20, 1928, on *Cornus* sp., (Frison, Hottes, and Ross). On Slide 9750 with alate viviparous females and nymphs.

Data with our other slides, containing alate and apterous viviparous females and nymphs, collected on *Cornus stolonifera* and *Cornus* sp., are as follows: East Peoria (July 22), Oregon (June 28) and Pekin (June 20), 1928; Lyle (July 14), 1929.

This species differs from the other members of the genus by characters given in the key. It is most closely allied to *caliginosa* n. sp., another dark-brown species occurring on *Cornus* in Illinois. *Aphis cornifoliae* is found on both the lower and upper surfaces of the leaves, whereas the other species recorded from *Cornus* in Illinois occur only on the lower surfaces of leaves and on the stems.

APHIS CRATAEGIFOLIAE FITCH

FIG. 90

Aphis crataegifoliae Fitch, Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 66.

This species was first reported from Illinois by Thomas (1879) and it was again recorded from this state by Davis (1910e) under the name of *Aphis brevis* Sanderson. Our records show it to be common and quite generally distributed over Illinois. It over-winters on apple and hawthorn, from the leaves of which it migrates in summer to the stems and crowns of red clover and certain other plants (Sanderson, 1902, and Patch, 1915a).

Data associated with our specimens, all collected on hawthorn (*Crataegus*) or red clover (*Trifolium pratense*), are as follows: Normal (June 21), 1883; Decatur (Sept. 29), Galena (June 26), Metropolis (June 1), Oakwood (Sept. 17), Urbana (May 19, 21, Sept. 26, Oct. 1, Dec. 19), 1928; Edwards-

ville (Sept. 11), Muncie (Sept. 22), Urbana (Oct. 11), 1929; Urbana (Oct. 20), 1930. Sexual forms were taken on *Crataegus* at Urbana on October 11, 1929.

APHIS DEBILICORNIS (GILLETTE & PALMER)

FIG. 20

Anuraphis debilicornis Gillette and Palmer, Annals of the Entomological Society of America, Vol. XXII, No. 1, March, 1929, p. 10.

Aphis helianthi Oestlund (not Monell), Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 52 ♂. *New synonymy*.



Fig. 20. Curling of leaves of wild sunflower, *Helianthus* sp., caused by *Aphis debilicornis* (Gillette and Palmer); Oakwood, July 22, 1929.

This species is here recorded from Illinois for the first time. Our records show that it is quite generally distributed throughout the state. The terminal leaves of its host curl tightly and twist (Fig. 20) when attacked by this aphid. It differs markedly from *Aphis helianthi* Monell, with which it has been confused. Descriptions of all forms are given by Gillette and Palmer (1929). No mention is made by these writers that it causes the leaves of its host to curl, but in answer

to our query Professor Palmer writes that "we are of the impression that they do curl leaves but can find no written record as to this point." We have taken this species every month from May to October, except August, on its host, *Helianthus* sp., and believe it is not a true migratory form.

Professor Palmer has checked slides of our material with typical specimens of *debilicornis* and reports that they agree.

Data associated with our specimens are as follows: Antioch (July 15), East Peoria (July 22), Muncie (Oct. 6), Oakwood (July 18), Shawneetown (May 27), 1928; Batchtown (June 25), Edwardsville (Sept. 11), Jonesboro (June 23), Oakwood (June 29), Urbana (July 19, Oct. 7), 1929; Oakwood (June 1), 1930. Sexual forms have been taken at Muncie (Oct. 6), 1928, and Urbana (Oct. 7), 1929.

APHIS DECEPTA new species

FIGS. 130, 281

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.45. Head and thorax dark chestnut brown. Abdomen deep golden yellow with a tinge of brown, except as follows: lateral portions of abdomen with large segmentally arranged brownish patches, these becoming confluent in the vicinity of the cornicles, so that abdomen posterior to cornicles, and a small connected patch near the anterior base of cornicles, as well as cornicles, cauda, and anal plate, are distinctly brownish. Antennae very uniform in color and essentially concolorous with the head. Femora chiefly brownish, fore legs usually lightest and hind legs dark, basal portion usually yellowish-brown; tibiae of all legs yellowish, except apices which are brownish for a distance equal to the length of the tarsi; tarsi brown. Beak brownish, somewhat darker towards apex. Stigma of fore wings only very faintly dusky; veins fine, fuscous, hind margin of wing near junction with anal vein distinctly fuscous.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with comparative lengths as follows: III—.34 to .49, average .42; IV—.23 to .24, average .24; V—.19 to .21, average .20; VI—.10 to .13, average .11 plus .36 to .40, average .38. Secondary sensoria (Fig. 281) essentially confined to the third antennal segment, but some specimens have a few sensoria on the fourth segment; usually large, with wide rims, completely covering the surface of the third segment and giving it a very tuberculate appearance; ranging from 37 to 48 on the third segment and none to four on the fourth segment, strongly imbricated. Beak reaching to coxae of the metathoracic pair of legs.

Thorax and appendages.—The prothorax has a pair of large, well-developed lateral tubercles. Fore wing with the second fork of the media usually much closer to the margin of the wing than it is to the first fork.

Abdomen.—First abdominal segment and the segment posterior to the cornicles each with a pair of large lateral tubercles. The cornicles (Fig. 130) slightly tapering from base to apex, strongly imbricated and with a flange at the apex; about twice the length of the cauda or one and one-half times the length of the fifth antennal segment, varying from .24 to .31 and averaging .28. Cauda with from five to seven hairs on a side, all of which are strongly bent inwardly; distinctly constricted at the middle. Anal plate reaching to middle of the cauda.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.57. Color yellow except as follows: a slight brownish cast on head; lateral portions of thorax in some specimens and small patches on abdomen immediately posterior to the cornicles dark brown; cauda and anal plate

brownish but not as dark as the cornicles. Legs essentially yellowish except dark brown apices of tibiae and all of tarsi. Basal segments of antennae usually concolorous with head, sometimes lighter, gradually shading to brownish about the middle of the fifth antennal segment and continuing this color to apex. Beak yellowish, except for brownish apex.

Head and appendages.—Average width of head across eyes, .47. Antennal segments with comparative lengths as follows: III—.39 to .43, average .41; IV—.21 to .24, average .23; V—.17 to .20, average .19; VI—.10 to .11, average .11 plus .29 to .36, average .32. Antennae without secondary sensoria, faintly imbricated. Beak reaching to the coxae of the metathoracic pair of legs.

Thorax and appendages.—The prothorax with a pair of large lateral tubercles.

Abdomen.—First and the segment posterior to the cornicles each with a pair of lateral tubercles. Cornicles similar to those of the alate viviparous female; about twice the length of the fifth antennal segment, averaging about .37. Cauda a little shorter than fifth antennal segment, with from six to seven hairs on a side and bent inwardly at apex.

Holotype.—Alate viviparous female; Urbana, Illinois, July 10, 1928, on *Pastinaca sativa*, (Frison and Hottes). On slide with morphotype (No. 4374). *Morphotype.*—Apterous viviparous female; same date as for holotype. On slide with holotype (No. 4374). *Paratypes.*—Twenty-nine slides of alate and apterous viviparous females, pupae and nymphs; Same data as for holotype. Slides Nos. 4372-4373, 10441-10458 and others unnumbered.

This species structurally suggests a close relationship with *Aphis luridis* new species, described in this paper, but may be separated from it by the fact that the fifth antennal segment never has secondary sensoria and the fourth segment has few, if any. This species occurs on the lower sides of the leaves.

APHIS FEMINEA HOTTES

FIG. 17

Aphis tuberculata Patch, Maine Agricultural Experiment Station, Bulletin 233, November, 1914, p. 261. *Name preoccupied.*

Aphis feminea Hottes, Proceedings of the Biological Society of Washington, Vol. 43, October 7, 1930, p. 183. *New name.*

This is the first time that this aphid has been recorded from Illinois. The red and black cherry aphid, as it has been styled by Patch, is a beautifully colored species. It completely incrusts the twigs and small branches of the black cherry and occasionally is found on leaves adjacent to a bark infestation. The sexual forms have not been described. Dr. Patch has kindly checked our determination of this species by comparison with typic specimens. This species was diligently searched for all over Illinois but was never located outside of Decatur, and we do not believe it has been reported previously except from Maine.

All our alate and apterous viviparous females were collected on *Prunus serotina* at Decatur, May 12, June 12 and 27, 1929.

APHIS FOLSOMII DAVIS

FIG. 201

Aphis folsomii Davis, Entomological News, Vol. XIX, No. 4, April, 1908, p. 145, pl. VII.

This species, originally described from Urbana, Illinois, by Davis, is widely distributed throughout the state. It is never abundant enough,

however, to be conspicuous and is not likely to become of economic importance. It occurs along the stems of the new growth and tendrils of Virginia creeper and Boston ivy. Davis has described the sexual as well as the viviparous forms.

Data associated with our viviparous specimens, all collected on *Parthenocissus tricuspidata* or *Parthenocissus* sp., are as follows: Muncie (Oct. 6), Oregon (June 27), Pekin (June 20), Urbana (June 7), 1928; Batchtown (June 25), Carbondale (June 21), Elizabethtown (June 20), Galena (July 10), Grayville (June 19), Olney (June 18), Ullin (June 21), Urbana (May 31, June 3), 1929.

APHIS FORBESI WEED

Aphis forbesi Weed, Bulletin of the Ohio Agricultural Experiment Station, Vol. 11, No. 6 (Second Series, No. 13), September, 1889, p. 148.

This species, named in honor of the late Professor S. A. Forbes, was first reported as occurring in Illinois by him. Davis (1910e) reports it as common throughout the state. It is a small dark bluish-green aphid normally occurring on the undersides of the leaves and stems, especially near the crown, of strawberry. It is also found frequently on the roots, to which it is carried by ants from the leaves and stems. It is a troublesome pest of strawberries, particularly of plants growing in sandy or light soils. The apterous sexual forms have been briefly described by Sanderson (1900).

Data associated with our viviparous specimens, all collected on *Fragaria*, are as follows: Kankakee (June 29), Oregon (June 28), 1928; Bement (May 24), Seymour (May 24), Urbana (May 22), 1929; Woodyard (April 14), 1930.

APHIS FUNESTA new species

FIG. 131, 203, 282

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.28. Head, thorax, and abdomen dark brown, shining. Lateral and posterior regions of abdomen sometimes mottled with lighter brown. Cornicles, cauda, and anal plate dark brown. Antennae with first and second segments colorous with head; either flagellum entirely dark brownish or third and fourth antennal segments and basal half of fifth segment light yellowish brown, with remaining portion of fifth segment and all of sixth dusky brown. Femora mostly dark brown, yellowish near base, metathoracic femora darkest, prothoracic femora lightest; tibiae conspicuously light yellowish with apical band equal to length of tarsi, dark brown, tarsi dark brown. Beak dark brown. Stigma of fore wings light yellowish brown, darker posteriorly, veins brown, posterior margin of wing in vicinity of anal vein brownish.

Head and appendages.—Average width of head across eyes, .39. Comparative lengths of antennal segments as follows: III—.20 to .26, average .23; IV—.19 to .24, average .21; V—.14 to .21, average .19; VI—.09 to .13, average .11 plus .20 to .27, average .24. Secondary sensoria (Fig. 282) confined to third antennal segment, usually arranged in a straight row, numbering from 4 to 7 and averaging 5. Primary sensorium on sixth antennal segment with a group of exceedingly small marginal sensoria at one side. All antennal segments imbricated. Beak reaching just beyond the middle of the mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of small peg-like lateral tubercles. Stigma of fore wings more or less shallow and sharply pointed. Second fork of media closer to margin of wing than to first fork.

Abdomen.—Cornicles (Fig. 131) .26 long, straight, imbricated throughout their length, and with the flange at apex very poorly developed. Cauda .15 in length (Fig. 203), distinctly constricted beyond middle, with the portion beyond constriction thin and more or less sharply pointed; with two or three hairs on each side, all strongly inwardly curved, besides numerous short spine-like setae. First and third abdominal segments and segment posterior to cornicles with small lateral tubercles. Anal plate normal.

APTEROUS VIVIPAROUS FEMALE. (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.43. Color essentially the same as in the alate viviparous female, except that the third, fourth, fifth, and base of sixth antennal segments are light yellowish, and the femora are a lighter shade of brown.

Head and appendages.—Average width of head across eyes, .43. Comparative lengths of antennal segments as follows: III—.24 to .36, average .29; IV—.17 to .24, average .20; V—.14 to .23, average .19; VI—.09 to .13, average .10 plus .14 to .23, average .20. Secondary sensoria absent. All antennal segments finely imbricated. Primary sensorium on sixth segment with a group of very small marginal sensoria at one side. Beak similar in length to that of alate viviparous female.

Thorax and appendages.—Prothorax with a pair of lateral tubercles.

Abdomen.—Cornicles about .36 long, otherwise similar to those of alate viviparous female. Cauda about .17 long, considerably more robust than the cauda of the alate viviparous female, constricted, and with two or three hairs on each side in addition to a dense covering of short spine-like setae. Anal plate normal. Lateral tubercles as in alate viviparous female.

Holotype.—Alate viviparous female; Beach, Illinois, August 29, 1929, on *Liatris* sp., (Frison and Hottes). On slide with paratypic apterous viviparous female and pupae. Slide No. 10386. *Morphotype*.—Apterous viviparous female; same data as holotype. On slide with paratypic alate and apterous viviparous female and nymph. Slide No. 10387. *Paratypes*.—Ten slides, containing alate and apterous viviparous females and pupae; same data as holotype. Slides Nos. 10388-10395 and others unnumbered.

This species was collected on the flowering stems of blazing star (*Liatris* sp.). Mounted material most resembles *A. laburni* Kalt., but differs in having the sixth antennal segment much longer than the cornicles. In life the difference is very marked, *A. laburni* being black and *A. funesta* mahogany red.

APHIS GOSSYPHII GLOVER

Aphis gossypii Glover, Report of the Commissioner of Agriculture of the Operations of the Department for the year 1876, (Government Printing Office, Washington, 1877), p. 36.

The cotton, or melon, aphid was first reported from Illinois by Forbes (1883) as a new species under the name of *Aphis cucumeris*. It is widely distributed throughout the world. In choice of food plants it is more cosmopolitan than most species of aphids and has been taken in Illinois on a large variety of plants including cotton—the host from which it was originally described. It is a serious pest of melons and cucumbers. In greenhouses it is apt to become a serious pest on a large variety of plants. Economic literature is full of articles dealing with the destruction caused by this plant louse, its bionomics, methods for control, and so on. In spite of all the attention paid to this insect by entomologists and others, nothing was known concerning the overwintering host, or hosts, of this species until the appearance of the

paper by Patch (1925) in which orpine, or live-forever, was shown to be a primary food plant in Maine. The sexual forms, both apterous, have been briefly described by Patch.

Data associated with our viviparous specimens are as follows: Normal (July 19, 1882; Chicago (June 14), Herod (May 29, Oct. 29), Rock Island (June 24), Urbana (May 9, Aug. 6, Oct. 5, 8, 18), 1928; Cairo (June 21, 22), Collinsville (Sept. 11), Oakwood (Oct. 13), Urbana (July 24, Aug. 19, 31, Oct. 6, 8, 9, 15, 16), 1929; Cerro Gordo (Oct. 15), Starved Rock State Park (May 13), Urbana (Oct. 20), 1930. Sexual forms and mating pairs were collected on *Oenothera* at Oakwood on October 22, 1930.

We have taken this species in Illinois on the following plants: *Achillea Millefolium*, *Anchusa myosotidiflora*, *Apium* sp., *Arabis Drummondii*, *Capsicum dulce*, *Coccoloba flendana*, *Coccoloba laurifolia*, *Crocus* sp., *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Diervilla* sp., *Gossypium* sp., *Helenium* sp., *Lagenaria vulgaris*, *Malva* sp., *Portulaca oleracea* sp., *Saxifraga splendens*, *Sedum reflexum*, *Spinacia oleracea*.

The typic slide of *Aphis cucumeris* Forbes is No. 1557 in the Survey collection.

APHIS HELIANTHI MONELL

Fig. 21

Aphis helianthi Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. I, p. 26.

This species was first reported from Illinois, and the sexual forms described, by Weed (1888) under the name of *Aphis cornifoliae* Fitch, a species with which it has been often confused. Since then it has been again reported from Illinois under its right name by Davis (1910e).

Aphis helianthi over-winters in the egg stage on dogwood, and in the spring it often causes very serious damage to ornamental plantings by twisting and curling the leaves (Fig. 21). In early summer it migrates to sunflower upon which host it may be collected all summer. Gillette (1910) has given a brief account of the biology of this species and the work of Bragg in demonstrating migratory habits of this species between dogwood and sunflower.

There has been much confusion in literature regarding the names used in connection with species of *Aphis* attacking *Cornus* and *Helianthus*. According to our collecting in Illinois, we have four species of *Aphis* on dogwood: the true *helianthi*, alternating between *Cornus* and *Helianthus*; *caliginosus* new species and *cornifoliae* Fitch, both of which thus far have been found only on *Cornus*; and *spiraecola*, which occurs on a large variety of plants, including *Cornus*. We have three species of *Aphis* attacking sunflower: *helianthi*, alternating between *Cornus* and *Helianthus* as already mentioned; *debilicornis*, which badly twists the terminal leaves (Fig. 20) and produces all forms on this host; and occasionally the omnivorous *A. rumicis*.

Our use of the name *helianthi* Monell is based upon a checking of a cotypic slide of this species kindly loaned by Professor J. J. Davis. Our use of the name *cornifoliae* Fitch is based upon an examination of typic specimens kindly loaned by Mr. P. W. Mason of the U. S. National Museum. It should be mentioned that we are informed by Pro-

fessor Oestlund that his description of *helianthi* Monell (1887) is based upon a male and accordingly is not to be compared with descriptions based upon alate viviparous females; and judging from his statements about the curling of leaves and subsequent collections of material, his reference is to what we are calling *debilicornis*.

Data associated with our viviparous specimens, all collected on *Cornus stolonifera*, *Cornus mas*, *Cornus* sp., or *Helianthus* sp., are as follows: Danville (Sept. 18), Herod (Oct. 12), Urbana (May 16), 1928; Beach (Aug. 29), East St. Louis (June 25), Galena (July 10), Macomb (May 3), Riverside (July 14), Rock Island (July 9), Springfield (May 2), Urbana (April 17, 22, 26, May 1, June 17, Aug. 16, 19), 1929.



Fig. 21. Curling of leaves of the dogwood, *Cornus mas*, caused by *Aphis helianthi* Monell; Urbana, June 22, 1929. Normal foliage on right and infested foliage on left.

APHIS ILLINOISENSIS SHIMER

FIG. 198

Aphis illinoensis Shimer, *Prairie Farmer*, Vol. 18, No. 20, November 17, 1866, p. 316.

The grapevine aphid has been shown by Baker (1917c) to overwinter on *Viburnum* and to migrate to wild and cultivated grapes in spring. Detailed descriptions of all forms are given by the same writer. This aphid is often destructive to cultivated varieties and is rarely absent from some of the succulent stems, leaves, tendrils, and



Fig. 22. Tendrils and leaves of the grape, *Vitis labrusca*, covered with the grape-vine aphid, *Aphis illinoensis* Shimer.

leaf petioles (Fig. 22) of such plantings. We have taken this species in twenty-three localities in all parts of Illinois, and it is safe to assume that it occurs in every county in the state.

Among the recently recovered types of plant lice described from Illinois by Thomas (1878) are those of *Siphonophora viticola*. These specimens agree with the species now going by the name of *illinoensis*

Shimer, and hence *viticola* Thomas can be definitely placed as a synonym of it as Davis (1910e) thought. Undoubtedly the Illinois records of "*A. vitis?* Scopoli" of Walsh (1862) refer to this species. The cotypes of *viticola* Thomas have been mounted in damar balsam on two slides. Slide No. 7698 has been designated as the *lectotypic* slide and Slide No. 7699 as a paratypic slide. Both contain specimens of alate and apterous viviparous females and nymphs. The original vial containing these typic specimens was assigned the number 33 by Thomas. The data associated with the typic slides are as follows: Irvington, Illinois, June 29, 1877, on grape.

Neotypic slide.—Since this species was originally described from Illinois by Dr. Shimer and there is no record of a type having been preserved, a slide (4098) in the Survey collection is selected as the neotype. The data associated with the neotypic slide are as follows: Oakwood, Illinois, on grape, July 18, 1928 (Coll. Frison and Hottes).

Our records for viviparous specimens of this species are as follows: Morris (July) and Villa Ridge (July 11), 1883; Cairo (June 2), Champaign (June 10-19), Havana (June 21), Jacksonville (June 18), LeRoy (June 20), Mattoon (June 10), Metropolis (June 1), Neoga (June 10), Oakwood (July 8-18), Pekin (June 20), Quincy (June 6), St. Joseph (June 17), Urbana (July 7-10), 1928; Beach (July 13), Cairo (June 22), Champaign (June 10), Effingham (June 18), Elizabethtown (June 20), Galena (July 10), Homer (June 29), Kansas (June 17), Oregon (July 12), Starved Rock State Park (July 6), 1929. Found on the young stems, leaves, tendrils, and leaf petioles of both cultivated and wild grapes (*Vitis*).

APHIS KNOWLTONI new name

Chaitophoroides middletonii (Thomas) Knowlton, Pan-Pacific Entomologist, Vol. VI, No. 1, July, 1929, p. 34.

In working over material belonging to the *maidi-radialis* or *middletonii* complex, we have studied specimens upon which the records and descriptions of *Chaitophoroides middletonii* of Knowlton (1929b) were based. The species he is calling *middletonii* Thomas does not come within the concept of *maidi-radialis* Forbes or *middletonii* Thomas as used by other writers, and since it represents an apparently new species we are proposing the new name of *knowltoni* for it. Knowlton has described and figured in detail the alate and apterous viviparous females and the apterous oviparous female, and his slides should be considered as the cotypic material. The two cotypic slides we studied of Knowlton's material bear the following data: Logan, Utah Sept. 4-7, 1926, on roots and crown of dandelion, collected by G. K. Knowlton. By courtesy of Mr. Knowlton these two slides have been assigned the numbers 8957 and 10865 and deposited in the Survey collection.

We have collected apterous viviparous specimens of this species at Urbana on two occasions, September 22, 1928, and May 22, 1929, each time on the roots of *Taraxacum officinale*.

APHIS LABURNI KALTENBACH

Aphis laburni Kaltenbach, Monographie der Familien der Pflanzenläuse, Aachen, 1843, p. 85.

This species was first reported from Chicago, Illinois, by Davis (1910e) under the name of *Aphis medicaginis* Koch. Thomas (1879)

mentions both *laburni*, as a synonym of *Aphis rumicis* L., and *medicaginis*. He did not, however, claim to know the species, and his references are not to be construed as Illinois records. Davis reports it as an important enemy of the black locust in the Chicago parks. We ourselves have taken this species only once, on the tender terminal shoots of young black locust.

Our viviparous specimens were collected on *Robinia Pseudo-Acacia* at Union Grove, Illinois, September 8, 1928, by Mr. C. C. Compton, and at McCusky, Illinois, June 26, 1931, by Frison and Ross.

APHIS LURIDIS new species

FIG. 268

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.79. Head and thorax dark chestnut-brown. Dorsum and venter of abdomen golden yellow, with brownish, segmentally arranged, lateral patches which tend to become confluent a short distance posterior to the base of the cornicles; cornicles, cauda, and anal plate dark brown. Antennae essentially concolorous with head except extreme base of third segment, which is lighter. Legs brownish, fore pair lightest and hind pair darkest, femora usually paler near base, tibiae usually darker at apical portion; tarsi concolorous with apices of tibiae. Fore wings with stigma smoky, veins light brown and only moderately well developed, posterior margin of wing brownish near junction with anal vein. Beak almost uniformly brownish.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with comparative lengths as follows: III—.37 to .49, average .44; IV—.16 to .21, average .19; V—.14 to .17, average .16; VI—.10 to .11, average .11 plus .26 to .31, average .28. Secondary sensoria (Fig. 268) are found on the third, fourth and fifth segments and are distributed as follows: III—28 to 40, average 35; IV—7 to 13, average 10; V—2 to 7, average 5. Secondary sensoria well developed, with wide rims, and very tuberculate; on the third antennal segment they appear to be quite equally distributed over its entire surface, except for a short free area near the base which is less in length than second segment and a tendency in some specimens towards a concentration near apex; on fourth and fifth segments confined mostly to one side of the segment; those on fourth segment scattered and those on fifth segment in a more regular row. All segments of the antennae, except where sensoria interfere, strongly imbricated. The beak is quite variable in length, in some specimens not quite reaching the coxae of the mesothoracic pair of legs and in others reaching the coxae of the metathoracic pair.

Thorax and appendages.—Prothorax with a pair of large, unusually well developed, lateral tubercles; mesothorax with a pair of wax glands on the ventro-lateral surface which are rather difficult to distinguish. Fore wing with second fork of the media variable in relation to margin of wing and first fork. Second joint of the tarsus, exclusive of claws, subequal to the base of sixth antennal segment.

Abdomen.—First abdominal segment and segment posterior to cornicles each with a pair of large, well-developed, lateral tubercles. Cornicles but slightly tapering from base to apex, a little less than twice the length of the fifth antennal segment, or about twice the length of the cauda, and averaging about .25 in length, strongly imbricated throughout and with a poorly developed flange at the tip. Cauda distinctly narrowed beyond middle, with from four to five hairs on a side, the four terminal hairs strongly bent inwardly, averaging about .15 in length. Anal plate rather deep and rounded.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.52. Head yellowish brown; thorax and abdomen golden yellow, except for a small brownish patch near posterior base of each cornicle. Cornicles

dark brown. Cauda and anal plate considerably lighter in color than similar structures of the alate viviparous female but still somewhat brownish or dusky. First and second antennal segments concolorous with the head; remaining segments almost uniformly dark brown, except basal half of third segment which is lighter in color than the apical half. Femora varying in color from almost uniform brown to basal half yellowish and apical half brownish, fore femora usually lightest; tibiae yellowish-brown with the exception of apical portions, which are darker brown; tarsi brownish. Beak brownish.

Head and appendages.—Average width of head across eyes, .41. Antennal segments with comparative lengths as follows: III—.33 to .37, average .36; IV—.16 to .19, average .17; V—.13 to .14, average .14; VI—.09 to .11, average .10 plus .17 to .21, average .20. Secondary sensoria usually present on third, fourth and fifth antennal segments; not very constant and varying considerably in size; on the third antennal segment they are confined to the apical one-third of the segment and they number from one to nine; scattered on the fourth and fifth antennal segments, on fourth segment varying in number from five to seven and on fifth segment from two to three; all segments strongly imbricated. The beak usually extends to the middle of the coxae of the metathoracic pair of legs.

Thorax and appendages.—Prothorax with a pair of large, well-developed, lateral tubercles.

Abdomen.—First abdominal segment and the segment posterior to the cornicles each provided with a pair of large, well-developed, lateral tubercles. Cornicles about three times the length of the base of the sixth antennal segment and averaging about .28 in length, tapering a trifle towards the apex, strongly imbricated, the flange poorly developed. Cauda about one-half the length of the cornicles, averaging about .16 in length; in shape it is similar to that of the alate viviparous female; with from five to six pairs of lateral hairs, the two terminal pairs strongly bend inwardly. Anal plate similar to that of the alate viviparous female.

Holotype.—Alate viviparous female; Carbondale, Illinois, June 4, 1928, on *Zizia* sp., (Frison and Hottes). Slide No. 10459. *Morphotype.*—Apterous viviparous female; Channel Lake, Antioch, Illinois, June 15, 1928, on *Zizia aurea*, (Frison and Hottes). On slide with alate viviparous female. Slide No. 10460. *Paratypes.*—Twenty-five slides of alate and apterous viviparous females, pupae and nymphs; all collected in Illinois by T. H. Frison, F. C. Hottes, and H. H. Ross from *Zizia aurea* or *Zizia* sp. The localities and dates are as follows: Beach (July 13, 1929); Carbondale (June 4, 1928); Channel Lake, Antioch (June 15, 1928); Metropolis (May 31, 1928); and Starved Rock State Park (June 13, 1928). Slides Nos. 10461-10480 and others unnumbered.

This species is very closely allied to *Aphis signatis*, a new species described in this paper. It may be distinguished by its color, the longer cornicles, and the fact that the apterous viviparous female has secondary sensoria on the third, fourth, and fifth antennal segments. It may be separated from both *A. nyctalis* and *A. signatis* by characters given in the key.

Specimens of this new species are found both in folded leaves and along the main flower stalks, particularly the latter.

APHIS MACULATAE OESTLUND

Aphis maculatae Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 61.

Aphis davisii Patch, Journal of Economic Entomology, Vol. 10, No. 4, August 1917, p. 419. *New synonymy.*

This species was first reported by Davis (1910e) from northern Illinois. *A. maculatae* Oestlund has been considered a synonym of

populifoliae Fitch, but Baker (1916a) has shown that the typic specimens of the latter belong to the genus *Clavigerus*, and hence *maculatae* is the first name available for this species. The original description of *A. populifoliae* Fitch is very unsatisfactory and there are some points upon which the description better fits this species than that of the species with which the name is associated on the basis of the existence of typic specimens.

Davis (1910e) and Patch (1913a) have referred to this species as *A. populifoliae* Fitch. Later, as a result of Baker's (1916a) work, showing *populifoliae* belongs in a different genus, Patch (1917) proposed the name *davisi*. Oestlund's (1887) *maculatae*, however, refers to this same species and hence has priority over the name proposed by Patch.

Patch (1913a) and Knowlton (1929b)—under name of *populifoliae* Fitch—have given good descriptions of the viviparous forms and the male. As far as known, the entire life cycle of this large, handsome species is spent upon the poplar or aspen. It occurs on the undersides of leaves and on succulent shoots.

Some recent writers have placed this species in the genus *Chaitophoroides* Mordvilko (1909), but we have not seen fit here to recognize this genus.

We have taken this species only once, upon *Populus tremuloides* at Oregon, Illinois, June 27, 1928.

APHIS MAIDI-RADICIS FORBES

FIGS. 23, 24

Aphis maidi-radicis Forbes, Seventeenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. Sixth Report of S. A. Forbes for the years 1889 and 1890, 1891, p. 64.

The corn root louse (Figs. 23, 24) was first reported from Illinois by Walsh (1862) under the name of "*Aphis maidis*?" Fitch." Since then, because of its economic importance, it has attracted the attention of many workers, so that the literature referring to it is very extensive. Forbes has published numerous papers concerning this insect, among which his articles of 1891 and 1895 are most important. In the 1891 paper, a new specific name was proposed, based upon experiments demonstrating that the aerial aphid on corn was not the same as the subterranean aphid on corn; both formerly going under the name of *maidis* Fitch.

The life history of this root louse in Illinois may be briefly summarized as follows: the eggs are cared for by common field ants during the winter; in spring the first young nymphs are placed by ants upon the rootlets of various plants such as smartweed; later the plant lice are transferred to certain plants including corn where the sexual forms are produced in late fall. The corn root aphid is one of the few aphids that seem to be almost, if not entirely, dependent upon ants. A more detailed but still comparatively short account of the corn root louse and suggested methods for control is given by Davis (1917).

Previous to the separation of *maidi-radicis* from *maidis* Fitch, Thomas (1879) named an *Aphis* found in Illinois on the roots of various plants, as *middletonii*. The close, if not co-specific, relationship of the latter to *maidi-radicis* appears never to have been suspected by Forbes. Now, however, there exists considerable doubt whether there are two or but one species involved; if the latter ever becomes demonstrated, the name of Thomas will have priority.

After a careful study of a large series of slides belonging to the Survey collection, and an equally large number kindly loaned to us by various individuals from Maine to California, we are still in a quandary whether we are dealing with one variable or two species in this state, though inclined to the view that only one species is involved. Since the name of *maidi-radicis* Forbes is so well estab-



Fig. 23. Alate and apterous viviparous females of the corn root aphid, *Aphis maidi-radicis* Forbes. (After Forbes: Ill. Ent. Rep. 18.)

lished in economic literature, we are not definitely considering it as a synonym of *middletonii* Thomas. The name *maidi-radicis* is associated by some students of aphids mostly with material collected on roots of corn, and the name of *middletonii* applied to a very similar appearing root louse found on such plants as *Erigeron*, *Solidago*, and *Aster*. The former is considered, too, as having on the average fewer secondary sensoria than the latter. We believe that only careful biological investigations can solve the problem of whether we are dealing with one, two, or perhaps three species. Such an investigation should study variation in color patterns shown by different generations on the same and different hosts, as well as variation in antennal structures, and should include transfer tests.

We are recording under one name (*maidi-radicis*) almost all of our Illinois material of this complex, because of general uniformity in structural and color characters. A few slides of viviparous specimens which approach most closely the present concept (Vickery, 1910) of *middletonii*, are left as undetermined.

Data associated with our specimens are as follows: Champaign (July 31), Normal (July 27), 1883; Freeport (July 16), 1884; Champaign (May 14, July 2, 5), Urbana (May 21, Aug. 7), 1886; Champaign (May 26, Oct. 18), Urbana (June 9), 1887; Urbana (June 19), 1888; Urbana (Oct. 3, 14),



Fig. 24. *Aphis maidi-radicis* Forbes on roots of *Erigeron philadelphicus*: Seymour, July 19, 1929.

1889; Urbana (June 26, 29, Oct. 6), 1891; Urbana (Aug. 5), 1893; Champaign (Oct. 17), Urbana (May 21), 1894; Buda (May 29), Bureau (May 30), Knoxville (May 25), 1901; Arnold (June 19), Urbana (June 14), 1928; Allerton (June 17), Clayton (June 21), Edwardsville (Sept. 11), Oakwood

(June 29), Seymour (July 19, Aug. 6) Starved Rock State Park (July 5), 1929; Beardstown (Nov. 7), Fairmount (Sept. 28), Humboldt (Nov. 12), Oakwood (Oct. 22), Vandalia (Nov. 14), 1930. Sexual forms taken in 1930 in October and November at Beardstown, Humboldt, Oakwood, and Vandalia. Mating pair taken at Oakwood on October 22 on corn roots.

Host plants are as follows: *Avena sativa*, *Erigeron*, *Plantago*, *Polygonum* sp., *Portulaca oleracea*, and *Zea Mays*.

APHIS MAIDIS FITCH

Aphis maidis Fitch, Transactions of the New York State Agricultural Society, Vol. XV, 1855 (Printed 1856), p. 550.

Walsh reported *Aphis maidis* Fitch as questionably occurring in Illinois. As he was dealing with a root-feeding form, the species referred to by him was unquestionably *Aphis maidi-radicis* Forbes and not the corn leaf aphid. The record of Thomas for *maidis* in Illinois undoubtedly covers both this species and *maidi-radicis*. The complete life history of this species, at least in the north-central states, is not known. It appears in corn fields in Illinois about mid-summer and remains there until late fall, rarely becoming of serious importance as a pest. The sexual forms are unknown, and the late appearance of *maidis* in Illinois is suggestive either that the corn leaf aphid has an alternate host or that it migrates each season from the south, where it is present during the winter months. Davis (1909a) gives a good account of the known biology and descriptions of this species.

Data associated with our viviparous specimens are as follows: Cedar Lake (Oct. 17), Normal (Oct. 25), Pekin (Aug. 8), Waterman (Aug. 25-26), 1882; Champaign (July 31), Heyworth (Aug. 11), 1883; Anna (Sept. 5), Champaign (Aug. 2-4), Normal (Aug. 11, Oct. 30, Nov. 8), 1884; Champaign (Sept. 1-14), Urbana (Sept. 3, Oct. 27), 1885; Centralia (Sept. 23), Champaign (Aug. 10, 21-23), Urbana (July 31, Aug. 1-9, Sept. 1), 1886; Urbana (July 31), 1888; Urbana (Sept. 2-23, Oct. 3-5), 1889; Champaign (July 23-31, Aug. 3), Farina (Sept. 19), Havana (June 13), 1894; Urbana (July 9-17), 1897; Aetna (July 11), 1905; Decatur (Nov. 4), 1928; Kappa (Aug. 14, Sept. 9), Mattoon (Sept. 10), Seymour (Oct. 30), Urbana (Sept. 8), 1929. Taken on corn, sorghum, broom corn, and grass.

APHIS MONARDAE OESTLUND

Aphis monardae Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 58.

Aphis monardae is here recorded from Illinois for the first time. It may be collected on the undersides of the leaves of horse mint, which it causes to curl.

Data associated with our viviparous specimens, collected on *Monarda* sp., are as follows: Carbondale (June 4), Champaign (July 15), Galena (June 26), Herod (May 29), Kankakee (June 29), Marshall (May 25), Oakwood (May 21, July 18), 1928; Flora (June 18), Urbana (June 1), 1929.

APHIS NEILLIAE OESTLUND

Aphis neilliae Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 59.

This species was first reported from Oak Park, Illinois, by Davis (1910e) who mentions appearance of apterous sexual forms in October.

Our observations at Urbana indicate that this species is at times extremely abundant on the undersides of the leaves and terminal portions of the new growth of nine-bark used in ornamental plantings.

Data associated with our viviparous specimens, all collected on *Physocarpus opulifolius*, are as follows: Galena (June 26), Urbana (July 26), 1928; Macomb (May 4), Urbana (April 13), 1929; Urbana (June 20, 30), 1930.

APHIS NERII FONSCOLOMBE

Aphis nerii Fonscolombe, Annales de la Société entomologique de France, Tome X, 1841, p. 179.

Aphis lutescens Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Article 1, p. 23. *New synonymy*.

This species was first reported, presumably from Illinois, by Thomas (1879) as "*Aphis nerii?* Fonscol." It was later reported from the vicinity of Chicago, Illinois, by Davis (1910e) as *Aphis lutescens* Monell. The bright golden yellow abdomen and the black head, antennae, cornicles, and cauda make this one of the most conspicuous of Illinois aphids. Good descriptions and illustrations of the viviparous forms are given by Essig (1911a, b).

An examination of cotypic slides loaned to us by Professor Davis convinces us that *lutescens* Monell is the same as *Aphis nerii*.

Data associated with our viviparous specimens are as follows: Elizabethtown (Oct. 12), Pekin (June 20), 1928; Cairo (June 22), Carbondale (Sept. 28), Centralia (Sept. 28), Collinsville (Sept. 11), Elizabethtown (Sept. 27), Forsyth (Oct. 27), Jonesboro (Sept. 28), Metropolis (Sept. 27), Oakwood (Oct. 13), Urbana (Oct. 3, 29, Nov. 10), 1929. Up to the present time we have taken this form only on its summer hosts: *Gonolobus lacris*, *Asclepias curassavica*, and *Convolvulus sepium*.

APHIS NYCTALIS new species

FIGS. 137, 197, 266, 267

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.94. Head, thorax, and abdomen in live specimens essentially dark brown or almost black. In mounted specimens the colors are as follows: Head and thorax mainly dark dusky brown. Abdomen yellowish to dark brown, the lighter areas with a distinct greenish tinge; lateral portions of abdomen with segmentally arranged fuscous spots which vary in size, shape, and intensity of color; lateral patches in the vicinity of the base of the cornicles extend only around the posterior side of the cornicles; a large blotch of the same color as the lateral spots just anterior to the anal plate. Cornicles black; cauda black except for mid-dorsal region anterior to constriction; anal plate concolorous with abdomen at base, darker towards outer margin. The antennae are but slightly lighter in color than the head and are practically uniformly colored throughout, except that often extreme base of third antennal segment is lighter in color than the remaining portion of segment. The femora of the prothoracic pair of legs are yellowish at their base and ventrally for almost one-half their length, remaining portions dark brown; meso- and metathoracic legs yellowish at extreme base, and remainder dark brown; tibiae uniformly dark brown; tarsi dark brown but sometimes lighter in color than tibiae. Stigma of fore wings brownish; the veins, and posterior margin of wing where it meets anal vein, light brown; the anal vein lightly bordered with brown. The beak with basal half yellowish, apical half dusky brown.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with comparative lengths as follows: III—.34 to .46, average .40; IV—.23 to .31, average .29; V—.17 to .23, average .20; VI—.07 to .14, average .11 plus .14 to .29, average .22. Secondary sensoria (Fig. 266) found on third, fourth and fifth antennal segments; sensoria on third segment appear to be about equally distributed over the entire surface of the segment, varying in number from 25 to 37 and averaging 32; fourth segment with sensoria about equally distributed throughout length but in some specimens there is a slight tendency for a grouping on one side of the segment varying in number from 12 to 20 and averaging 16; sensoria on fifth segment in a straight row, varying in number from 1 to 3; sensoria on third and fourth segments varying in size, the larger ones being unusually large; all sensoria have wide rims. The beak extending about to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Prothorax with a pair of well developed lateral tubercles. Stigma of fore wings sharply pointed at apex. Position of second fork of media somewhat variable, but always nearer to the apex of the wing than to the first fork. Hind tarsi, exclusive of claws, about one-half the length of the cornicles.

Abdomen.—The first segment of the abdomen and the segment posterior to the cornicles have lateral tubercles, which may be easily overlooked because they are not well developed. Cornicles (Fig. 137) with straight, sides, tapering but slightly towards apex, flange at apex poorly developed, strongly imbricated throughout their length, in length either equal to or subequal to the length of the fourth antennal segment and averaging about .27. Cauda (Fig. 197) about equal to the length of the fifth antennal segment and averaging about .19, constricted in the middle; with four to five hairs on a side, the two terminal pairs being very strongly inwardly bent.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.87. Head and thorax mainly dark dusky brown. Abdomen yellowish-brown with a greenish tinge, particularly greenish on lateral portions. Abdomen free from lateral patches anterior to cornicles, but there is a small brownish patch directly posterior to the cornicles; posterior extremity of the abdomen, cornicles, cauda (posterior to constriction), and patch directly anterior to anal plate are dark brownish, almost black. First and second antennal segments concolorous with head; basal half of third antennal segment lighter in color than remaining half, which is brown; remaining antennal segments uniformly brownish. Legs similar in color to those of the alate viviparous female.

Head and appendages.—Average width of head across eyes, .47. Antennal segments with comparative lengths as follows: III—.29 to .41, average .35; IV—.23 to .33, average .27; V—.13 to .23, average .19; VI—.11 to .14, average .12 plus .19 to .29, average .23. The secondary sensoria of this species present an interesting study in variation: two specimens, apparently normal in every other way, have no secondary sensoria; many other specimens, also apparently normal apterous females, not presenting the appearance of alate individuals in which the development of the wings has been arrested, have secondary sensoria on the third, fourth, and fifth antennal segments (Fig. 267). Other evidence that these female specimens having secondary sensoria are not potentially alate viviparous females is provided by the peculiar arrangement of the sensoria, which is entirely unlike that of the alate viviparous female and utterly unlike that of any *Aphis* species now known to the writers. The sensoria, when present, are distributed on the segments as follows: third segment 2-9, average 5; fourth segment 8-17, average 10; fifth segment 1-2, generally 1. The sensoria on the third segment, although scattered, are limited to the apical one-third of the segment—a very unusual occurrence outside of the genus *Cinara*; on the fourth segment they cover a little more than one side of the segment but extend from end to end; and on the fifth segment the sensoria appear to have no fixed position.

Thorax and abdomen.—Similar to alate viviparous female.

Holotype.—Alate viviparous female; Cairo, Illinois, June 2, 1928, on *Senecio glabellus*, (Frison and Hottes). Slide No. 10338. *Morphotype.*—Apterous viviparous female; same data as for holotype. Slide No. 10339. *Paratypes.*—Twenty-four slides of alate and apterous viviparous females, pupae and nymphs; all collected at Cairo, Illinois, on *Senecio glabellus*, June 2, 1928, and June 22, 1929, (Frison and Hottes). Slides Nos. 10340-10357 and others unnumbered.

Superficially this new species is suggestive of *Aphis rumicis* L. It differs, however, as follows: the apterous viviparous female normally has secondary sensoria on the third and fourth antennal segments; in alate viviparous females the secondary sensoria are more numerous on the third and fourth antennal segments and are invariably present on the fifth antennal segment; and there is no pulverulent matter on the dorsum of live specimens. It differs from *Aphis senecionis* Williams, a closely related species, of which cotypic slides were kindly loaned by the U. S. National Museum, in having a longer fourth antennal segment and in the larger number of sensoria on the third, fourth, and fifth antennal segments. It may be separated from *A. luridis* and *A. signatis* by characters given in the key.

This aphid congregates on the main flower stalks, particularly near the flower heads. It is easy to detect because its color contrasts with that of its host plant.

APHIS OESTLUNDI GILLETTE

Aphis oestlundi Gillette, Annals of the Entomological Society of America, Vol. XX, No. 3, September, 1927, p. 345.

This species was probably first reported from the state by Davis (1910e) as *Aphis ocnotherae* Oestlund. *A. oestlundi* is almost impossible to separate from *A. gossypii* on the basis of morphological or color characters, but appears to be distinct biologically, having the evening primrose (*Ocnothera biennis*) as its primary host. We have tried without success to transfer spring migrants from *Ocnothera* to squash plants in the insectary so that in spite of a lack of visible differences, it seems necessary to consider the species on *Ocnothera* distinct from *A. gossypii*.

In Illinois we have found in October the sexual forms of *oestlundi* on the undersides of leaves of *Ocnothera* located near the ground. Since they have never been described, the following descriptions are given. Both sexes are apterous and resemble closely the brief descriptions of the sexual forms of *gossypii* given by Patch.

APTEROUS MALE

Length from vertex to tip of anal plate, .77. Color of head, including antennae, brown; thorax yellowish green with pleurae and lateral and anterior areas of dorsum brownish; abdomen yellowish green with the cornicles and external genitalia brown. Legs, with coxae, most of femora, apices of tibiae, and tarsi, brown; trochanters, bases of femora, and most of tibiae, luteous. Width of head across eyes .27. Antennae imbricated, comparative lengths as follows: III—.19, IV—.13, V—.14, VI—.07 plus .21. Secondary sensoria distributed at random over segments as follows: III—13 to 19, average 17; IV—7 to 10, average 8; V—3 to 8, average 6. Third and fourth segments often fused. Cornicles and cauda as in other forms, respectively .13 and .09 in length.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of anal plate, 1.10. Color deep bright green, with the head, antennae, cornicles, anal plate, apices of tibiae, and tarsi, brownish. Width of head across eyes .29. Antennae only five-segmented, imbricated, the comparative lengths as follows: III—20, IV—10, V—.09 plus .21. Secondary sensoria lacking, fourth segment with a small circular primary sensorium near apex, fifth with one at base of terminal filament. Cornicles and cauda as in other forms, respectively .17 and .09 in length. Hind tibiae .43 in length, robust, slightly swollen and tuberculate, with distinct setae; sensoria, if present, small and very inconspicuous.

Allotype.—Apterous male; Slide No. 9712, Oakwood, Illinois, October 22, 1930, on *Oenothera*, (Frison and Ross). On slide with two apterous males.

Morphotype.—Apterous oviparous female; Slide No. 9716, same data as allotype. On slide with two oviparous females.

Data associated with our viviparous specimens, which were all taken on *Oenothera biennis*, are as follows: Carbondale (June 4), Galena (June 26), Havana (June 21), Herod (May 31), Marshall (May 25), Pekin (June 20), Quincy (June 6), Shawneetown (May 27), Starved Rock State Park (June 12), 1928; Columbia (Sept. 11), Monticello (May 24), Peoria (May 4), Springfield (May 2), Urbana (Aug. 13), 1929; Garden Prairie (May 15), Oakwood (Oct. 22), 1930. Sexual forms and mating pairs, also on *Oenothera*, at Muncie on October 22, 1930.

APHIS PADI LINNAEUS

FIG. 25, 210

Aphis padi Linnaeus, 1758, Systema Naturae, Editio Decima, p. 451.

This species is here recorded from Illinois for the first time. Our observations indicate that it has possibilities of doing serious injury to peach and plum trees, the leaves of which it causes to curl (Fig. 25), and it has been recorded by Smith (1921) as the most important plant louse affecting plum trees in Idaho. According to Theobald (1927), who presents a good account of the habits and structural characters of this species, it over-winters on plum and migrates to numerous plants during the summer months. Our records from Illinois indicate that the life cycle is about the same in Illinois as in Europe. This species has heretofore been known under the name of *Aphis helichrysi*; we follow Theobald in considering it a synonym of *padi*.

Our data associated with our viviparous specimens are as follows: Bondville (Sept. 26), Evanston (Feb. 19), Urbana (Sept. 3, Oct 7, 9), 1929; Evanston (March 12), 1930. Oviparous females were found at Bondville on September 26, 1929. Our material was collected in fall from *Prunus* and in winter in greenhouses on *Senecio cruentus* and *Myosotis*.

APHIS PERSICAE-NIGER SMITH

Aphis persicae-niger Smith, Entomologica Americana, Vol. VI, No. 6, Brooklyn, June, 1890, p. 101.

The black peach aphid has been previously reported as a common pest of peach in Illinois by Davis (1910c). According to various writers, it over-winters on the roots of peach and migrates to the leaves and tender shoots in spring. The alate and apterous viviparous

females have been described and figured by Smith (1890) and Gillette (1908b). The sexual forms are unknown.

We have records of this species only from Carbondale (May 14) and Herod (May 31), 1928, both times upon *Prunus Persica*.



Fig. 25. Curling of leaves of peach, *Prunus Persica*, caused by *Aphis padi* Linnaeus; Urbana, Oct. 7, 1929.

APHIS POMI DEGEER

FIG. 14

Aphis pomi DeGeer, Mémoires pour servir à l'histoire des Insectes, Tome III, 1773, p. 53, Pl. 3, fig. 20.

Because the green apple aphid is widely distributed throughout the world and is often a serious pest of apples, it has been the subject of many extensive investigations. Until rather recent years, it was known as *A. mali* Fabricius, but at the present time the prior name of *pomi* is in use. The recognized presence of *pomi* in Illinois certainly dates back to Thomas (1879), and it is possible that some of the Illinois material recorded by Fitch (1855) belonged to this species. Davis (1910e) recorded it from Illinois as "common and often destructive pest of the apple."

The most complete account of the structural features and biology of this aphid is that by Baker and Turner (1916), and their summary of it is here reproduced:

"The life history of *Aphis pomi* may be briefly outlined as follows: The egg is laid upon the tender twigs of the apple, though occasionally it is laid upon the bark of the older twigs. It is light yellow when laid, but later changes to shining black. Development for a few days is very rapid, after which the egg rests for the winter. When the revolution of the embryo is completed in the spring, an increase in temperature will cause the egg to hatch. Before this revolution a high temperature only tends to destroy it. Early in April the egg hatches by a uniform splitting over the insect's head.

"The stem mother is wingless and becomes mature in about 10 days. She produces summer forms, both winged and wingless, with the winged ones predominating. There are 9 to 17 generations of the summer forms at Vienna, Va. After the second generation the wingless forms always outnumber the others, but winged forms may occur in every generation. They become rare toward the end of the season. On the other hand, a wingless line may be carried from the stem mother to the egg. A third form, the intermediate, may occur throughout the summer.

"The wingless sexes begin to appear about the 1st of September. They occur in all generations, from the eleventh to the nineteenth, inclusive, and probably also in the ninth and tenth.

"The summer wingless forms and the oviparous females, which live longer than the males, remain on the trees at Vienna, Va., until the leaves drop, usually about the middle to the last of November.

"Mating commences toward the close of September, one male usually serving more than one female. Both sexes feed. The oviparous female may lay infertile eggs if not reached by a male, and these eggs do not become black. The fertile egg develops to the resting stage before the first heavy frosts; otherwise it may be winterkilled and will not hatch to a stem mother the following spring."

The bulletins of Gillette and Taylor (1908), Matheson (1919), Hodgkiss (1919), and Patch (1923a) contain much additional data of interest to the general student of aphids. Control measures are fully dealt with in numerous experiment station publications and general entomological texts (Metcalf and Flint, 1928).

Within recent years the opinion has been advanced that *A. pomi* DeGeer and *A. spiraccola* Patch (= *spiracella* of American authors) were the same species. Patch (1923a and 1929) has concluded that the two forms are very closely related and "originated from a common ancestor and that the diverging forms have not yet gone far on their separate ways," and has shown that *Spiraea* is the over-wintering host in Maine for a form (*spiraccola*) whose summer generations frequent a great variety of plants. Likewise, the other form (*pomi*) finds apple an "all year host," although it may have summer generations on other plants and can be colonized on *Spiraea*. In this paper we have considered the two as separate species because of the following: (1) the presence in the south of an aphid attacking citrus which is of much economic importance and clearly of the *spiraccola* race; (2) the fact that the tibiae of the oviparous females of *spiraccola* are swollen and thickly studded with sensoria, whereas in *pomi* on apple they are comparatively slender and with but few sensoria; (3) the males of *spiraccola*, as far as known, are winged and the males of *pomi* apterous.

Data associated with our specimens are as follows: Normal (Aug. 24), 1883; Anna (Aug. 13), 1884; Normal (Aug. 7), 1885; Urbana (July 13), 1897; Antioch (June 15), Bement (July 17), Carbondale (June 4), Centralia (Aug. 6), Champaign (June 21), East Peoria (July 22), Elizabethtown (May 29, 31), Galena (June 26), Kankakee (June 29), LeRoy (June 29), Metropolis (May 31, June 1), Mt. Carmel (May 26), Oregon (June 28), Rock Island (June 24), Shawneetown (May 27), St. Joseph (June 17), Union County (June 4), Urbana (May 22-24, June 6, 11, 14, 23), 1928; Beach (June 13), Decatur (June 12), Homer (June 17), Mitchell (June 25), Newton (June 17), Rock Island (July 7), Waukegan (July 13), 1929; Effingham (Nov. 13), 1930. Material collected on *Crataegus* sp., *Prunus domestica*, *Prunus japonica*, *Prunus virginiana*, *Pyrus americana*, *Pyrus communis*, and *Pyrus Malus*.

APHIS PULCHELLA new species

FIGS. 141, 276

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.36. Head, thorax, and abdomen, including cornicles, cauda, and anal plate, dark brown in mounted specimens. In life the body of this species is distinctly bluish-green and somewhat pulverulent. First and second antennal segments concolorous with head or lighter; flagellum entirely yellowish brown. Front and middle femora brown, paler at base; hind femora with extreme base light yellowish, remainder dark brown; tibiae light yellowish, with dark brown band at apex equal to length of tarsi; tarsi dark brown. Beak yellowish brown, extreme tip blackish. Stigma and veins light yellowish brown, posterior margin of front wings in vicinity of anal vein light brown.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with the following comparative lengths: III—.24 to .36, average .32; IV—.23 to .30, average .26; V—.23 to .30, average .27; VI—.09 to .14, average .13 plus .16 to .30, average .26. Secondary sensoria (Fig. 276) limited to third antennal segment, arranged in a straight row and numbering from 5 to 7, averaging 6. Antennae with very sparse, short, fine hair; all segments imbricated. Primary sensoria of fifth and sixth segments subequal. Beak extending to, or a little beyond, the mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of peg-like lateral tubercles, which are only slightly larger than the ocular tubercles. Second fork of media closer to margin of wing than to first fork. Hair on tibiae short, about half the width of tibiae, spine-like and comparatively sparse.

Abdomen.—First abdominal segment and segment posterior to cornicles with small, lateral tubercles. Cornicles (Fig. 141) averaging .17 in length, straight, neither constricted nor with a distinct flange at apex, the apical third smooth, the remaining portion imbricated. Cauda .16 in length, constricted just anterior to tip of anal plate, with from 4 to 5 pairs of lateral hairs, the apical pair strongly incurved. Anal plate normal.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.63. General color as in alate viviparous female, differing in having the appendages a slightly deeper shade of brown.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with comparative lengths as follows: III—.21 to .27, average .30; IV—.11 to .29, average .21; V—.13 to .24, average .21; VI—.10 to .13, average .11 plus .16 to .27, average .22. Secondary sensoria absent. Primary sensorium on sixth antennal segment with a group of much smaller marginal sensoria on one side. Antennae imbricated, with comparatively few, fine, short hairs. Beak extending slightly beyond mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of lateral tubercles.

Abdomen.—First abdominal segment and segment posterior to cornicles with small lateral tubercles. Cornicles averaging .19 in length, in shape

similar to those of alate viviparous female. Cauda averaging .19 in length, slightly constricted beyond the anal plate, and with 6 to 7 pairs of lateral hairs, the terminal ones incurved.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.17. Color essentially as for alate viviparous female except as follows: antennae being darker; first three segments almost concolorous with head, the remainder of antennal segments decreasing in intensity towards apex, the extreme bases of all segments of flagellum luteous. Genital organs dark brown.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with the following comparative lengths: III—.26 to .39, average .33; IV—.24 to .33, average .28; V—.23 to .29, average .25; VI—.10 to .13, average .12 plus .27 to .33, average .29. Secondary sensoria numerous on third, fourth, and fifth segments, very much crowded on one side (hence difficult to count), distributed as follows: III—22 to 33, average 29; IV—17 to 22, average 20; V—10 to 14, average 11. Primary sensorium of sixth antennal segment with a group of small marginal sensoria on one side. Beak reaches to, or just beyond, the mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of lateral tubercles. Venation of wings as in alate viviparous female.

Abdomen.—Cornicles averaging .11 in length, slightly imbricated with the flange very poorly developed. Cauda averaging .14 in length, indistinctly constricted near base, and with from 4 to 5 hairs on each side.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.52. Head, thorax, and abdomen, including cornicles, cauda, and anal plate, reddish brown. Antennae entirely yellowish-brown. Beak yellowish-brown, tipped with darker brown. Femora reddish-brown; tibiae slightly lighter except their apices which are tipped with dusky-brown; tarsi dusky-brown.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with the following comparative lengths: III—.21 to .24, average .23; IV—.17 to .26, average .21; V—.21 to .24, average .22; VI—.11 to .13, average .12 plus .21 to .27, average .25. Antennae without secondary sensoria; primary sensorium on sixth segment with a group of several marginal sensoria; all antennal segments imbricated. Beak reaching to meta-thoracic coxae. Hind tibiae considerably swollen except for apical portion; with numerous sensoria, one tibia with approximately 90.

Thorax and appendages.—Prothorax with a pair of small lateral tubercles.

Abdomen.—First abdominal segment and segment posterior to cornicles with small lateral tubercles. Cornicles about .16 long, distinctly imbricated at base, less distinctly at apex, with very poorly developed flange. Cauda about .20 long, only slightly constricted, and with 6 to 7 pairs of lateral hairs, the terminal ones incurved. Anal plate normal.

Holotype.—Alate viviparous female; Beach, Illinois, July 13, 1929, on *Euphorbia* sp., (Frison and Hottes). On slide with alate viviparous female and nymphs. Slide No. 10404. *Allotype.*—Alate male; Centralia, Illinois, September 26, 1929, on *Euphorbia* sp., (Frison and Hottes). On slide with apterous viviparous females and apterous oviparous female. Slide No. 10405. *Morphotype.*—Apterous viviparous female; same data as for holotype. On slide with alate viviparous females, apterous viviparous female, and pupa. Slide No. 10406. *Morphotype.*—Apterous oviparous female; same data as allotype. On slide with male, apterous oviparous female, and apterous viviparous females. Slide No. 10407. *Paratypes.*—Fifty-one slides, containing alate and apterous viviparous females, alate males, apterous oviparous females, pupae, and nymphs, all with same data as holotype or allotype; and five slides, Kankakee, Ill., September 19, 1930, on *Euphorbia*. Slides Nos. 10408-10440 and others unnumbered.

APHIS RHAMNI FONSCOLOMBE

Aphis rhamni Fonscolombe, Annales de la Société Entomologique de France, Tome X, 1841, p. 177.

This aphid is here reported from Illinois for the first time. It has been studied very thoroughly by Patch (1924) under the name of *A. abbreviata* Patch, with especial reference to its seasonal migration. Theobald (1927), also, describes the forms of this species and gives its synonymy. The winter and spring host is buckthorn (*Rhamnus*), from which the spring migrants disperse to a large number of summer hosts. The sexual forms mate on the buckthorn in fall, and the over-wintering eggs are deposited on this host.

Data associated with our viviparous specimens are as follows: Galena (June 26), Quincy (June 6), Havana (June 21), 1928; Homer (June 29), Kappa (Sept. 9-22, Oct. 1-3), Starved Rock State Park (Aug. 14), 1929; Kappa (May 7), 1930. Males and oviparous females taken at Kappa (Oct. 3), 1929, on *Rhamnus lanceolata*. Viviparous specimens taken on *Amsonia Tabernaemontana*, *Hibiscus* sp., *Nepeta cataria*, and *Rhamnus lanceolata*.

APHIS ROCIADAE COCKERELL

FIG. 191

Aphis rociadae Cockerell, Transactions of the American Entomological Society, Vol. XXIX, 1903, p. 115.

Aphis rociadae is here recorded from Illinois for the first time. When abundant on its host, larkspur, it causes severe leaf curling and encrusts the flower stalks. The sexes are produced in Illinois in May, so that the larger part of the year is passed in the egg stage. This seems to be an adaptation to the short period of growth of its host. The hairs of this species are somewhat enlarged apically—a rather peculiar characteristic for a species belonging to this genus. Davis (1919) has described all forms.

Data associated with our viviparous specimens are as follows: Evans-ton (July 15), 1929; Decatur (May 12), Elk Grove (June 7), Kappa (May 7, 13), 1930. Oviparous females collected at Kappa, May 13, 1930. All specimens collected on *Delphinium tricornis*.

APHIS ROSEA (BAKER)

FIG. 139

Anuraphis roseus Baker, Canadian Entomologist, Vol. LIII, No. 4, April, 1921, p. 95.

The rosy apple aphid in many sections of the country is one of the most injurious plant lice feeding upon the leaves of apple. At times, when the infestation is particularly heavy, the fruit is attacked and characteristic deformed "aphid apples" produced. Outbreaks of this aphid are fortunately scarce in Illinois.

This species has been previously reported from Illinois by Davis (1910e) under the name of *A. sorbi* Kaltenbach as a "rather uncommon species, which I have taken only in southern Illinois." Baker and Turner (1916), under the name of *A. malifoliae* Fitch, have

given a complete account of its general biology and descriptions of its various forms. Their studies show that it migrates between apple and plantain, the latter plant serving as the summer host.

Data associated with our viviparous specimens, all collected on *Pyrus Malus* or *Plantago* sp., are as follows: Marshall (May 25), Murphysboro (June 22), Shawneetown (May 27), Union County (June 5), and Urbana (May 23, 28, June 6), 1928; Oakwood (Oct. 22), 1930.

APHIS RUBICOLA OESTLUND

Aphis rubicola Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 60.

This species is now recorded from Illinois for the first time, and our observations indicate that it is not common. The name of *A. rubicola* Oestlund (1887) was thought by Hottes (1930a) to be preoccupied by *rubicola* Haldeman (1844). Haldeman's specific name referring to a different, red-colored species, however, was spelled *rubecula* in the original description, as photostat copy shows, and hence the name of *rubicola* Oestlund is still available. The best account of the life history of this raspberry aphid is that by Winters (1929b), whose studies have shown that *A. rubiphila* Patch is a synonym of *rubicola* Oestlund.

Data associated with our specimens, all taken on raspberry (*Rubus* sp.), are as follows: Kansas (June 17), Macomb (May 4), 1929.

APHIS RUMICIS LINNAEUS

FIGS. 26, 28, 80

Aphis rumicis Linnaeus, Systema Naturae, Editio Decima, 1758, p. 451.

This species (Fig. 26) is the most common dark-colored aphid found in Illinois. Its polyphagous habits make it of special importance as a pest in home gardens and greenhouses. It may be that this plant louse, supposed to be a native of Eurasia, was found in Illinois by Thomas (1879) but he gives no definite data regarding its occurrence. There are, however, specimens in the Survey collection proving its existence in the state at least as early as 1884. Gillette (1910) was apparently the first to record it from Illinois. The biology of this insect has been studied from various angles by many investigators. These studies have shown it to be a somewhat variable species, attacking over two hundred plants, and over-wintering on *Chenopodium*, *Evonymus*, *Rumex*, and *Viburnum*. Good technical descriptions of all its forms and much other summarized information concerning its biology can be found in the papers of Davidson (1921), Horsfall (1925), and Theobald (1927).

Data associated with our viviparous specimens are as follows: Normal (May 9, June 2), 1884; Normal (May 24), Urbana (April 28), 1887; Albion (May 26), Antioch (June 15), Bement (July 7), Cairo (June 2), Carbondale (June 4), Champaign (May 19), East Peoria (July 22), Elizabethtown (May 29), Galena (July 27), Golconda (Oct. 13), Havana (June 21), Kankakee (June 29), LeRoy (June 20), Mattoon (June 10), Metropolis (June 1), Muncie (Oct. 6), Oregon (June 27), Pekin (June 20), Quincy (June



Fig. 26. One of the most common aphids in Illinois, *Aphis rumicis* Linnaeus, on dock, *Rumex crispus*; Urbana, June 10, 1929.

6), Rock Island (June 23), Shawneetown (May 27), Urbana (May 14, 17, 22, 23, 28, June 6-7, July 7, 23, Sept. 26, Oct. 19, Dec. 5), 1928; Arlington Heights (July 3), Beach (July 13), Decatur (June 12), DesPlaines (July 10), Elizabethtown (June 20), Grayville (June 19), Herod (June 21), Homer (June 17), Kankakee (July 14), Lewistown (May 4), Macomb (May 4), Melrose Park (July 12), Oakwood (May 17, Sept. 22), Oregon (July 9), Putnam (May 5), Springfield (May 2), Starved Rock State Park (July 5, 6, Urbana (April 18, May 1, June 28), Waukegan (July 13), Woodford (July 5), 1929; Effingham (Nov. 13), Urbana (Oct. 20, 24), 1930. Sexual forms taken at Effingham (Nov. 13), and Urbana (Oct. 20-24), 1930, on *Viburnum* sp. Mating pair taken at Urbana (Oct. 20), 1930. What are apparently stem mothers were collected in early May on *Evonymus*, *Ligustrum*, *Rumex*, and *Viburnum*. We have not given a complete list of food plants upon which we have found this aphid, since it attacks almost any plant.

APHIS RUMICIS VAR. GERARDIAE (THOMAS)

Siphonophora gerardiae Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 65.

Colonies of blackish aphids which agree very well with Thomas' original description of *Siphonophora gerardiae* have been collected on *Gerardia pedicularia* at Tremont, Indiana, and at Kankakee and Oakwood, Illinois, in September and October. Thomas' material was collected on "*Gerardia tenuifolia*" at Carbondale, Illinois, during the latter part of September. This species has not been reported since the time of its original description. Although our material is closely related to *A. rumicis* L., agreeing well in color and general proportions, we have preserved the name of *gerardiae* as a varietal name. This is because the cornicles average longer and the secondary sensoria are much more numerous on the fourth (6-16) and fifth antennal segments than in *rumicis* and its variations as defined by David-son (1921), Horsfall (1925), and Theobald (1927).

Possibly future investigations will prove that the material reported upon here is entitled to specific recognition. If not, the concept of *rumicis* must be broadened. That we are here dealing with the form named as *gerardiae* by Thomas seems certain to us.

Data associated with our viviparous specimens from Illinois are as follows: Kankakee (Sept. 19) and Oakwood (Oct. 5), 1930. All material collected on *Gerardia pedicularia*.

APHIS SALICETI KALTENBACH

Aphis saliceti Kaltenbach, Monographie der Familien der Pflanzenläuse, I Theil, Aachen, 1843, p. 103.

This species was redescribed by Thomas (1879) as new by the name of *Siphonophora salicicola* from specimens sent to him from Peoria, Illinois. Although we have not collected it in southern Illinois, we believe it will eventually be found to be distributed throughout the state. Davis (1910e) reports it as common in Illinois. For descriptions of all forms and further information, the reader is referred to the papers by Gillette and Bragg (1918) and Theobald (1927). This aphid is peculiar in that the sexual forms are produced during spring or early summer, as is the case with *A. rociadae*

Cockerell. According to all who have studied this species, it does not have an alternate host.

Specimens of *S. salicicola* Thomas (Vial 67—Thomas) were included among the cotypic material recently recovered and have been mounted in damar balsam. This slide (8178) contains portions of alate viviparous females. The data associated with this cotypic slide are as follows: Peoria, Illinois, June 28, 1877, on *Salix*, collected by A. E. Smith.

Data associated with our viviparous specimens are as follows: Champaign (May 16, 23), Kankakee (June 29), Oregon (June 27), Starved Rock State Park (June 12), 1928; Springfield (May 2), Starved Rock State Park (July 6), 1929; Urbana (May 6), 1930. All material collected on *Salix* sp.

APHIS SAMBUCIFOLIAE FITCH

Aphis sambucifoliae Fitch, Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 66.

This species was first reported from Illinois by Thomas (1879) as *Aphis sambuci* Linn. Thomas questionably considered *Aphis sambucifoliae* Fitch as a synonym of *A. sambuci*. It was again reported by Davis (1910e) as common on "ornamental elder in the Chicago parks." Theobald (1927) has recently considered this species a synonym of *A. sambuci*, but we are holding *sambucifoliae* as distinct, largely on the basis of additional secondary sensoria on the fourth and fifth antennal segments. Sanborn (1904) has given fairly complete descriptions of the viviparous forms. Davis mentions the sexual forms on elder in September and October in northern Illinois.

We have never taken this species on elder growing in the open; it seemingly shows a decided preference for hosts growing in shaded situations.

Data associated with our viviparous specimens are as follows: Urbana (June 13, July 23, Oct. 18), 1928; Grayville (June 19), Jonesboro (June 23), Rock Island (July 9), Starved Rock State Park (July 5), Urbana (April 8, Sept. 23), 1929; Effingham (Nov. 13), Urbana (Oct. 13, 20 and 24), Vandalia (Nov. 14), 1930. Oviparous females have been taken as follows: Effingham (Nov. 13), Urbana (Oct. 13-24), and Vandalia (Nov. 14), 1930. All specimens from *Sambucus canadensis*.

APHIS SANBORNII PATCH

Aphis sanbornii Patch, Maine Agricultural Experiment Station, Bulletin 225, February, 1914, p. 52, figs. 8, 9, 10, 11, 29, 35.

The green gooseberry aphid, now recorded from Illinois for the first time, is a fairly common species on gooseberry in the north-central portion of the state. We have never found it doing conspicuous injury to its host since it usually attacks only the terminal leaves or a few shoots on a bush. Our determination of this species has been verified by Dr. Patch, who has described the species and further reported on its biology (1927), stating that it alternates between *Ribes* and *Epilobium*.

Data associated with our viviparous specimens are as follows: Galena (June 26) Oakwood (July 18), Starved Rock State Park (June 12, 13), 1928; El Paso (July 5), Kansas (June 17), 1929; Rock Island (June 3), 1930. All specimens collected on *Ribes Grossularia* and *Ribes nigrum*.

APHIS SIGNATIS new species

FIG. 265

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.57. Head and thorax dark brown; abdomen dark green except for some dark brown, lateral, segmentally arranged patches. Cauda, anal plate, and cornicles greenish-brown to dark brown. Dark lateral patches at base of cornicles more or less confluent posteriorly. Antennae with two basal segments concolorous with head, flagellum a uniform, slightly lighter brown. Front femora with base and ventral margin yellow, apical and dorsal portions light brown; middle and hind femora yellowish at extreme base, the remainder dark brown. Tibiae yellowish to light brown, slightly darker at base, and with a distinct dark brown band at apex, not quite as wide as twice length of tarsi. Tarsi brown. Stigma, costa, veins, and hind margin of wing at apex of anal vein, brown. Beak yellowish-brown, its extreme apex dark brown.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with the following comparative lengths: III—.39 to .47, average .43; IV—.19 to .24, average .21; V—.17 to .21, average .19; VI—.09 to .10, average .09 plus .16 to .29, average .22. Secondary sensoria (Fig. 265) present on third, fourth, and fifth segments, distributed as follows: III—38 to 43, average 41; IV—7 to 15, average 11; V—1 to 8, average 4. Third segment, except extreme base, thickly dotted with sensoria, tuberculate in appearance; fourth and fifth segments with scattered sensoria, those on the fifth usually confined to one side; sensoria with rather wide rims. Beak extending to middle of mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of well-developed, peg-like, lateral tubercles. Second segment of hind tarsus subequal to one-half the length of the cornicles. Second fork of media closer to margin of wing than to first fork, distance from first to second fork usually twice the distance from second fork to margin of wing.

Abdomen.—First segment and segment posterior to cornicles with lateral tubercles, the tubercles posterior to cornicles small and difficult to locate. Cornicles subequal to three times the length of the base of sixth antennal segment, middle portion usually slightly narrowed, otherwise of almost uniform thickness throughout, strongly imbricated, flange present but poorly developed. Anal plate broadly rounded. Cauda subequal to three-quarters length of cornicle, constricted in the middle, with four to five hairs on each side, the terminal hairs strongly incurved.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.79. Head, including two basal segments of antennae, prothorax, anterior portion of mesothorax, and pleurae of meso- and metathorax, chocolate brown; remainder of thorax and abdomen, except brown patch at base of cornicles, dark green. Cornicles, cauda, and anal plate brown to dark greenish-brown. Flagellum of antennae varying in color; younger specimens usually with the third and most of the fourth antennal segment yellowish, the apical portion shading to dark brown; older specimens sometimes with only the basal half of the third antennal segment yellowish, the remainder dark brown. Legs and beak essentially as in the alate viviparous female.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III—.33 to .43, average .39; IV—.17 to .21, average .18; V—.16 to .20, average .19; VI—.09 to .11, average .11 plus .21 to .29, average .25. Secondary sensoria absent. Beak extending to metathoracic coxae.

Thorax and Abdomen.—Prothorax with a pair of well-developed lateral tubercles. Tarsi, exclusive of claws, equal to half length of cornicles. First segment of abdomen and segment posterior to cornicles with a pair of lateral

tubercles. Cornicles subequal in length to the terminal process of the sixth antennal segment, usually straight, sometimes slightly constricted as in the alate viviparous female. Cauda more than half as long as the cornicles.

Holotype.—Alate viviparous female; Urbana, Illinois, May 22, 1929, on *Zizia* sp., probably *Z. aurea*, (Frison and Ross). On slide with alate viviparous female, apterous viviparous females, and pupae. Slide No. 10396.

Morphotype.—Apterous viviparous female; same data as holotype. On slide with alate viviparous female, pupae, and nymphs. Slide No. 10397.

Paratypes.—Thirty-three slides containing alate and apterous viviparous females, pupae, nymphs, collected in Illinois, by T. H. Frison, F. C. Hottes, H. H. Ross, and C. O. Mohr, on *Zizia aurea*, *Zizia* sp., *Angelica* sp., and *Sanicula* sp. The localities and dates are as follows: Channel Lake, Antioch (June 15), Herod (May 29), 1928; and Urbana (May 22), 1929; Charleston (May 31), and Homer (May 29), 1931. Slides Nos. 10398-10403 and 10881-10898, and seven others unnumbered.

This species resembles somewhat in color and structure *Aphis sambucifoliae* Fitch, from which it differs in having shorter, feebly constricted cornicles, fewer tubercles on the abdomen, and a peg-like prothoracic tubercle. It may be separated from *A. luridis* and *A. nyctalis* by characters given in the key.

APHIS SOLIDAGINIFOLIAE WILLIAMS

FIG. 27

Aphis solidaginifoliae Williams, University Studies, University of Nebraska, Vol. X, No. 2, March, 1911, p. 58.

This species has not been previously recorded from Illinois. Although we have collected it at only four localities, it is probably more widely distributed than our records indicate. It is peculiar among most members of the genus *Aphis* in that it causes the leaves of goldenrod (*Solidago* sp.) to fold longitudinally and become pod-like (Fig. 27). Since these folded leaves still retain their normal green color, infested plants are apt to be overlooked. The body of this species has long, somewhat knobbed hairs. The viviparous females have been described by Davis (1911c). The oviparous females formed the basis for the original description.

Data associated with our viviparous specimens are as follows: Danville (Aug. 4), Muncie (Oct. 6), 1928; Rock Island (July 7), Urbana (Aug. 21), 1929. Oviparous females were collected at Muncie, October 6, 1928.

APHIS SPIRAECOLA PATCH

Aphis spiraeella Schouteden, Gillette, Journal of Economic Entomology, Vol. 3, No. 5, October, 1910, p. 404. Misidentification.

Aphis spiraeicola Patch, Maine Agricultural Experiment Station, Bulletin 233, November, 1914, p. 270.

This species is very closely related to *A. pomi* and has been considered by some writers as identical. Our reasons for holding it as distinct have already been given (see *pomi*). The articles by Patch (1923a and 1929), previously cited, show that *spiraeicola* over-winters on *Spiraea* in Maine and has a large number of summer hosts.

This aphid is referred to in the southern states as the "citrus aphid" and is of considerable economic importance. It is a pest on

Spiraea used in ornamental plantings in all parts of Illinois. Davis (1910e) records it from Illinois by the name of "*spiracella* Schout.??" and doubts its identity with the European species. He also describes the viviparous females and mentions the swollen tibiae bearing numerous sensoria.



Fig. 27. Pseudo-galls on leaves of golden rod (*Solidago*), caused by *Aphis solidaginifoliae* Williams. Normal foliage on right and infected foliage on left; Seymour, Aug. 22, 1929.

Data associated with our viviparous specimens are as follows: Berwyn (June 14), Cairo (June 3), Carbondale (June 4), Centralia (Aug. 6), Champaign (May 21), Elizabethtown (May 29, 31), Galena (June 26), Havana (June 22), Kankakee (June 29), LeRoy (June 20), Marshall (May 25), Metropolis (May 31, June 1), Mt. Carmel (May 26), Muncie (Oct. 6), Oregon (June 27, 28), Ottawa (June 14), Pekin (June 20, July 22), Quincy (June 6), Rock Island (June 22), Shawneetown (May 27), St. Joseph (June 17),

Urbana (May 22, 29, June 7, July 10, 26), 1928; Alton (June 25), Decatur (June 12), Edwardsville (Sept. 11), Grayville (June 19), Jerseyville (June 25), Pontiac (Aug. 12), Starved Rock State Park (July 6), Urbana (May 15, June 10), 1929; Des Plaines (June 16), Urbana (Sept. 28), 1930. Collected on *Acer Negundo*, *Apocynum* sp., *Aquilegia canadensis*, *Asclepias* sp., *Catalpa speciosa*, *Celastrus scandens*, *Convolvulus* sp., *Cornus stricta*, *Cucumis sativus*, *Helichrysum bracteatum*, *Hydrangea* sp., *Liatris squarrosa*, *Pastinaca sativa*, *Polygonum* sp., *Rumex crispus*, *Vernonia* sp., *Viburnum* sp., *Vitis* sp.

APHIS SPIRAEPHILA PATCH

FIG. 208

Aphis spiracphila Patch, Maine Agricultural Experiment Station, Bulletin 233, November, 1914, p. 270.

This aphid, previously unrecorded from Illinois, frequents the terminal shoots of native meadow-sweet, *Spiraea salicifolia*. According to Patch, it apparently spends its whole life cycle on this one host. Through the kindness of Dr. Patch our specimens were compared with cotypic material of this species. The original description refers to the apterous viviparous form as being "huckleberry black with a slight white bloom of wax powder." Our Illinois material was more pinkish than black.

Data associated with our viviparous specimens are as follows: Havana (June 22), 1928; Beach (July 13), Rock Island (July 9), Urbana (July 1), 1929; Rock Island (June 3), 1930.

APHIS TULIPAE FONSCOLOMBE

Aphis tulipae Fonscolombe, Annales de la Société Entomologique de France, Vol. X, 1841, p. 167.

This more or less cosmopolitan species is recorded from Illinois for the first time here. It has been recorded in Europe feeding upon various liliaceous plants, including *Gladiolus* and *Tulipa*, and upon carrot and parsley roots. According to Theobald (1927), Felt (1909) redescribed it under the name *Aphis gladioli* from gladioli in America, presumably New York. A little information concerning this species is given by Theobald (1927).

The single Illinois collection was made at Urbana, October 19, 1930, on roots of carrot (*Daucus carota*).

APHIS VERNONIAE THOMAS

Aphis vernoniae Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 10.

This species, described from Illinois by Thomas in 1877, has not been recorded from the state since then. Our records indicate that it is quite generally distributed throughout Illinois. It occurs on the flower stems of its hosts. Supplementary descriptions have been given by Sanborn (1904).

Cotypes of this species were included among the typic material of Thomas recently recovered. They have been mounted in damar balsam on

four slides: Slide No. 7704 has been designated as the *lectotypic* slide, and Slides Nos. 7705-7707 as *paratypic* slides. Data associated with the lectotypic and paratypic slides, alate and apterous viviparous females, are as follows: Carbondale, Illinois, June 20, 1877, collected by Thomas on *Vernonia fasciculata*.

Data associated with our viviparous specimens are as follows: Carbondale (June 4), Morton (July 22), Urbana (July 23), 1928; Cairo (June 22), Elizabethtown (June 20), Hardin (June 25), Newton (June 17), Olney (June 18), Rock Island (July 7), Urbana (August 21), 1929. Collected on *Eupatorium purpureum* var. *maculatum*, *Helenium autumnale*, and *Vernonia fasciculata*.

APHIS VIBURNICOLA GILLETTE

FIG. 28

Aphis viburnicola Gillette, Entomological News, Vol. XX, No. 6, June, 1909, p. 280.

Aphis viburnicola Gillette was first reported from Illinois by Davis (1910e). Our records indicate that it is very widely distributed in Illinois. This species over-winters on snowball (*Viburnum*) and in



Fig. 28. Pseudo-galls on the snowball, *Viburnum Opulus* var. *Americana*, started by *Aphis viburnicola* Gillette, later occupied by *Aphis rumicis* Linnaeus and *Aphis viburniphila* Patch; Urbana, June 10, 1929. Normal foliage on left and infested foliage on right.

early spring causes the leaves to curl and form pseudo-galls (Fig. 28). After a short time the species leaves its primary host for an unknown one and then returns again in autumn. Gillette (1909c) has given detailed descriptions of all the forms found on the winter host.

Data associated with our viviparous specimens are as follows: Antioch (June 15), Decatur (Oct. 20), Urbana (May 17), 1928; Lewistown (May 4), Macomb (May 4), Rantoul (April 24), Springfield (May 2), Urbana (April 16), 1929; Carbondale (April 17), Effingham (Nov. 13), Lawrenceville (April 14), Metropolis (April 17), Urbana (Oct. 20, Dec. 20), 1930. Sexual forms have been taken at Effingham (Nov. 13) and Urbana (Dec. 20), 1930. A mating pair was collected at Effingham. All specimens collected on *Viburnum Opulus* var. *americanum* or *Viburnum* sp.

APHIS VIBURNIPHILA PATCH

FIG. 28

Aphis viburniphila Patch, Journal of Economic Entomology, Vol. 10, No. 4, August, 1917, p. 416.

This species is probably the aphid reported by Thomas (1879) from Carbondale, Illinois, under the name of *Aphis viburni* Scop. Specimens of this species are often found mixed with colonies of *Aphis rumicis* Linn. The alate and apterous viviparous females and the apterous oviparous females have been described by Patch (1917), who states that the species is present all year on *Viburnum*.

Data associated with our viviparous specimens of this species are as follows: Galena (June 26), Havana (June 21), Kankakee (June 29), LeRoy (June 20), Metropolis (June 1), Oregon (June 27, 28), Pekin (June 20), 1928; Catlin (May 17), Rantoul (April 24), Springfield (May 2), Urbana (April 16), 1929; Urbana (June 23), 1930. All material collected on *Viburnum* sp.

APHIS ZILORA new species

FIGS. 143, 194, 278

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.11. Head and thorax dark dusky brown, lateral portions of prothorax and posterior portion of head somewhat yellowish. Abdomen green. Cornicles greenish, slightly dusky apically. Cauda yellowish brown, anal plate brown. Antennae uniformly brown. Femora light yellowish brown, more yellowish near base; basal portions of tibiae yellowish, or light yellowish brown with apical portions darker brown; tarsi brown. Beak yellowish brown at base shading to light dusky brown at apex. Stigma of fore wings light dusky brown, brownish subcostal infusion present; veins and posterior margin of wings in vicinity of anal veins concolorous with stigma.

Head and appendages.—Average width of head across eyes, .33. Comparative length of antennal segments as follows: III—.14 to .16, average .14; IV—.10 to .13, average .12; V—.10 to .13, average .11; VI—.07 to .09, average .08 plus .14 to .19, average .17. Secondary sensoria (Fig. 278) confined to third antennal segment, arranged in a straight row, numbering from 3 to 5, usually 3, in most cases confined to apical portion of segment. Primary sensorium on sixth segment with marginal sensoria apparently absent. All antennal segments imbricated. Beak reaching to metathoracic coxae except in one specimen in which it just fails to reach the mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of lateral tubercles, anterior lateral margin of mesothorax also with lateral tubercles. Stigma of fore wings quite shallow and bluntly pointed. Radial sector only slightly curved. Second fork of media lacking in one specimen, in others extremely variable in regard to first fork and margin of wing, usually closer to the latter. Ventral portion of mesopleuron with a wax-pore plate.

Abdomen.—Cornicles (Fig. 143) .09 long, straight, faintly imbricated, without flange at apex, subequal to base of sixth antennal segment, and either equal to or shorter than the cauda. Cauda (Fig. 194) .10 long, not constricted, with four inwardly curved hairs on each side, apex sharply pointed. First abdominal segment and segment posterior to cornicles with a pair of lateral tubercles.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.09. Color of head, thorax, and abdomen light green. Cornicles yellowish with the apical portion dusky. Cauda and anal plate brownish. Antennae yellowish, except for apical segments, which are light dusky. Beak yellowish

with the apical portion brown. Femora yellowish with apical portions dusky; tibiae yellowish with the apical portions brownish; tarsi brown.

Head and appendages.—Average width of head across eyes, .30. Comparative lengths of antennal segments for specimens with six-segmented antennae as follows: III—.09 to .13, average .11; IV—.09 to .10, average .09; V—.09; VI—.07 to .09, average .08 plus .14 to .16, average .15. Comparative length of antennal segments for specimens with five-segmented antennae (which are the most common) as follows: III—.17 to .21, average .19; IV—.09 to .11, average .09; V—.07 plus .14 to .19, average .15. Secondary sensoria absent. Primary sensorium on last antennal segment with a group of five marginal sensoria. All segments of antennae imbricated. Beak reaching to metathoracic coxae.

Thorax.—Prothorax with a pair of lateral tubercles, anterior portion of mesothorax also with lateral tubercle.

Abdomen.—Abdomen with a pair of lateral tubercles near anterior portion and a pair posterior to the cornicles. Cornicles .10 long, cauda .09 long, cornicles, cauda and anal plate similar to those of alate viviparous female.

Holotype.—Alate viviparous female; Beach, Illinois, August 29, 1929, on *Liatrix elegans*, (Frison and Hottes). On slide with paratypic alate and apterous viviparous females. Slide No. 10525. *Morphotype.*—Apterous viviparous female; same data as holotype. Slide No. 10526. *Paratypes.*—Four slides of alate and apterous viviparous females and nymphs. Same data as holotype. Slides Nos. 10527-10529 and one other unnumbered.

This species belongs to the *maidi-radicis* group, and may be separated from closely allied forms by the characters given in the key to the genus *Aphis*.

GENUS ASIPHONAPHIS WILSON AND DAVIS

Key to the Species of the Genus *Asiphonaphis*

1. Antennae with very few hairs; lateral tubercles on abdomen slender, much longer than width at base (Fig. 315); pulverulent in life.....*anogis* n. sp. p. 225
- Antennae with numerous hairs about as long as width of antennal segments; lateral tubercles on abdomen stout, about as long as width at base (Fig. 312); not pulverulent in life.....*pruni* Wilson & Davis p. 227

ASIPHONAPHIS ANOGIS new species

FIGS. 205, 270, 315

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.68. Body in live specimens covered with a dense coat of whitish down, more abundant posteriorly than anteriorly. In mounted specimens the head is dark dusky brown, becoming almost black at the vertex, but usually a lighter color in the vicinity of the eyes and posterior to them. The prothorax on the dorsum is concolorous with the head; laterally it has a greenish tinge and is considerably lighter in color; the meso- and metathoracic segments are dark dusky brown, certain portions being almost black. The abdomen is yellowish brown, the cauda and anal plate dusky brown. All antennal segments essentially concolorous with lighter portions of the head. Basal portion of anterior femora slightly lighter in color than remaining femora, femora essentially dusky brown or dusky yellowish brown near the base, shading gradually to a more intense dusky brown at the apex; tibiae almost uniformly dusky brown; tarsi dusky brown. Stigma fuscus; veins fine, dark brown, very faintly bordered with brown, anal vein darkest and

most heavily bordered, posterior margin of wing near articulation with anal vein thickened and brownish. Beak yellowish-brown with the apical segments darker than others.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III—.33 to .46, average .41; IV—.21 to .31, average .27; V—.14 to .26, average .21; VI—.09 to .17, average .14 plus .14 to .26, average .20. Numerous secondary sensoria on third and fourth antennal segments (Fig. 270), sometimes one or two secondary sensoria are found on the fifth segment; in structure they are large and have wide rims; sensoria on the third antennal segment number from 9-16 with an average of 12 and are arranged in an irregular row; sensoria on fourth antennal segment arranged in a regular row and number from 3 to 7 with an average of 5. The primary sensorium on segment six is small; in fact, the only way that it can be distinguished from the marginal sensoria is by the fringe of hair which is around its outer circumference. The beak is exceedingly variable in length; in some specimens perhaps failing to reach beyond the midway point between the coxae of the pro- and mesothoracic segments, whereas in others it may extend as far as the coxae of the metathorax.

Thorax and appendages.—Prothorax with a pair of tooth-like lateral tubercles. The tarsal segments are quite long, about equaling in length the first and second antennal segments combined. Normally the media of the fore wings is twice-branched, the second branch occurring much closer to the margin of the wing than it is to the first branch; abnormal venation is common, the media of both wings being only once-branched, or one wing with the media once-branched and the other wing with the media twice-branched, or with the media twice-branched on one wing and thrice-branched on the other.

Abdomen.—Abdomen entirely covered with wax glands similar to those found in *Amphiceroides pulverulens* (Gillette) or *Gypsoaphis oestlundii* (Hottes), and with seven pairs of tooth-like lateral tubercles (Fig. 312). Cauda (Fig. 205) not quite as long as the hind tarsae exclusive of claws, not constricted, and distinctly tapered toward apex, with from three to five pairs of lateral hairs, the terminal hairs usually strongly incurved; length varies from .13 to .14. Anal plate narrow, scarcely wider than the cauda at the base and about one-half as long.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.63. Body in live specimens entirely covered with a dense coat of whitish down. In mounted specimens the head, thorax, and abdomen are dark brown, and the cauda and cornicles as in the alate viviparous female. First and second antennal segments light brown, lighter in color than the head, sometimes slightly dusky on the anterior margin; basal half of third antennal segment concolorous with second segment, apical half more fuscous; fourth, fifth, and sixth segments uniformly light brown. All legs of about the same intensity of color, similar to the legs of the alate form except that the apical portions of the tibiae are considerably darker than the remaining portions. Beak colored as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .36. Antennal segments with comparative lengths as follows: III—.30 to .40, average .36; IV—.17 to .24, average .21; V—.17 to .24, average .21; VI—.13 to .14, average .14 plus .19 to .21, average .20. Normally there are no secondary sensoria. Hairs on antennae twice as long as width of segment and fine. The beak usually extends to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Prothorax with lateral tubercles. Hairs on legs fairly abundant, fine, and very long, about twice width of segments.

Abdomen.—Entire surface covered with wax glands and with seven pairs of tooth-like lateral tubercles (Fig. 315). Cauda about equal to the length of the hind tarsi exclusive of claws, measuring from .11 to .14 and averaging .13, usually with four pairs of lateral hairs on a side, the terminal hairs strongly incurved. Anal plate about twice as wide as the cauda at the base and about half as long.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.54. General color practically the same as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with the following proportions: III—.37 to .43, average .40; IV—.26 to .29, average .27; V—.23 to .24, average .23; VI—.11 to .14, average .12 plus .13 to .24, average .21. Secondary sensoria present on the third, fourth, and fifth antennal segments; although scattered, confined largely to one side of the segment; distributed throughout the length of the third and fourth antennal segments; confined to the basal two-thirds of fifth segment; varying in size, the largest usually being on the third segment and the smallest on the fifth segment; varying in number, third segment with from 18 to 25 and average of 24, fourth segment with from 13 to 21 and an average of 15, fifth segment with from 5 to 10 sensoria and an average of 7. The marginal sensoria are almost as large as the primary sensorium on the sixth antennal segment. The beak reaches to or beyond the coxae of the metathoracic pair of legs.

Thorax and appendages.—Same as in the alate viviparous female.

Abdomen.—Similar in all respects to abdomen of alate viviparous female except that the cauda does not taper off to the apex so quickly and is more blunt at the tip. Male genitalia dark dusky-brown.

Superficially the structure of the male is so nearly like that of the alate viviparous female that a hasty examination might lead to confusing the two. The male genitalia are often rather obscured, thus leaving the presence of the more numerous secondary sensoria on the fourth and fifth antennal segments as the best means of differentiation between the two sexes.

Holotype.—Alate viviparous female; Decatur, Illinois, October 19, 1929, on *Pilea pumila*, (Hottes and Tauber). Slide No. 10747. *Allotype.*—Alate male; Decatur, Illinois, October 13, 1929, on *Pilea pumila*, (Hottes and Tauber). Slide No. 10748. *Morphotype.*—Apterous viviparous female; Decatur, Illinois, October 20, 1929, on *Pilea pumila*, (Hottes and Tauber). Slide No. 10749. *Paratypes.*—Thirty-five slides of alate viviparous and apterous females, pupae and nymphs, collected at Decatur, Illinois, October 13-20, 1929, on *Pilea pumila*, (Hottes and Tauber). Slides Nos. 10750-10772 and others unnumbered.

This species feeds along the main stem near the top of the plant and along the main stalk of the flower stem. When seen on their host plant they do not suggest aphids at all, because they are so closely clustered along the stem and often obscured by their downy flocculence. This new species can be separated from *A. pruni* Wilson and Davis, the only other species in the genus, by the following characters: the entire surface of the body is covered with wax glands, the lateral tubercles are considerably less developed and thinner, and there are no hairs on the antennae.

ASIPHONAPHIS PRUNI WILSON AND DAVIS

FIG. 312

Asiphonaphis pruni Wilson and Davis, Entomological News, Vol. XXX, No. 2, February, 1919, p. 39.

This species is here reported from Illinois for the first time. We have found it only in the extreme northern portion of this state. Very little information is available concerning its range in North America. The typic material was collected in Wisconsin. According to our observations, *pruni* causes a severe curling of the leaves of its host.

Descriptions of the viviparous females and male are given by Wilson and Davis (1919).

Data associated with our viviparous specimens are as follows: Chicago (June 13), 1928; Beach (July 13), Galena (July 10), 1929. All collected on *Prunus virginiana*.

GENUS BRACHYCOLUS BUCKTON

BRACHYCOLUS TRITICI GILLETTE

Brachycolus tritici Gillette, Entomological News, Vol. XXII, No. 10, December, 1911, p. 441.

Davis (1910d) first reported this species from Illinois. It has not been taken since. Parker (1916) refers to this aphid as the "Western wheat aphid" and states that at times it is a serious pest of winter wheat in Montana and that it also attacks barley. According to Parker this plant louse over-winters in the egg stage on wheat. All forms have been described by Gillette (1911c).

Data associated with our viviparous specimens are as follows: Aurora (Sept. 24), 1908, collected from grass by J. J. Davis.

GENUS BREVICORYNE VAN DER GOOT

BREVICORYNE BRASSICAE LINNAEUS

Figs. 3, 160, 204

Aphis brassicae Linnaeus, Systema Naturae, Editio Decima, 1758, p. 452.

The cabbage aphid is discussed at some length by Thomas (1879), and it is very probable that his remarks can be construed as indicating the presence of this louse in Illinois in 1879 although no definite Illinois locality is mentioned. Davis (1910e) reports it from Illinois as "our most generally destructive aphid of the vegetable gardens." Although our records for the cabbage aphid are confined to the central and northern parts of the state, it no doubt occurs everywhere within our territory. It is a pest in Europe as well as in this country. Herrick and Hungate (1911) have published a detailed account of this species and show that the entire life cycle is spent upon cabbage or closely related plants.

Data associated with our viviparous specimens are as follows: Champaign (Oct. 1, 2), Normal (Sept. 10), Rose Hill (Sept. 26), 1883; Decatur (Nov. 11), 1928; Kansas (June 17), 1929; Arlington Heights (Sept. 29), 1930. Males are in the collection from Champaign, October 1-2, 1883. All collected on *Brassica oleracea*.

GENUS CAVARIELLA DEL GUERCIO

CAVARIELLA AEGOPODII (Scopoli)

FIG. 206

Aphis aegopodii Scopoli, Entomologica Carniolica, 1763, p. 399.*Hyadaphis pastinacae* Davis, Journal of Economic Entomology, Vol. 3, No. 6, December, 1910, p. 493. In part misidentification.

An examination of material belonging to Professor J. J. Davis proves that some specimens of this species were included in his records of *Hyadaphis pastinacae* from Illinois in 1910. These slides are as follows: Chicago, Illinois, Oct. 1, 1908, on *Zizia aurea*, and Oak Park, Illinois, August 4, 1909, on willow. No Illinois records, however, have been previously reported under this specific name. Dr. Theobald has kindly determined specimens of this species submitted to him. Although we have collected this species only on *Salix* it is known to migrate to *Aegopodium* and other plants, as the records of Davis (1910e) and others demonstrate.

Data associated with our Illinois specimens, all collected on *Salix*, are as follows: Elizabethtown (June 30), Grayville (June 19), Starved Rock State Park (July 6), 1929; Seymour (June 20), 1930.

GENUS CEROSIPHA DEL GUERCIO

CEROSIPHA RUBIFOLII (THOMAS)

FIGS. 29, 138, 192, 275

Sipha rubifolii Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 121.

This is a minute yellowish-green aphid with five-segmented antennae. Our records indicate it is widely distributed in Illinois. Although small and usually not very abundant, its habit of twisting and curling the leaves (Fig. 29) of blackberry (*Rubus* sp.) makes it conspicuous. It is likely that Thomas described this species from material collected in Illinois. Davis (1910e) was the first to definitely record the species from Illinois stating it "is very common in Illinois, curling and injuring the foliage of the cultivated and wild blackberry." Winter (1929b) has summarized most of the literature relating to this species.

Data associated with our slides of viviparous specimens of this species are as follows: Albion (May 26), Carbondale (June 4), Champaign (Aug. 9), East Peoria (July 22), Herod (May 29), Metropolis (May 31, June 1), Mt. Carmel (May 26), Oakwood (May 12, 20, July 18, Sept. 17), Oregon (June 28), 1928; Elizabethtown (June 21), Hardin (June 25), Kansas (June 17), Lisle (July 14), Maryville (Sept. 11), Oakwood (June 1), Olney (June 18), Rock Island (July 7), Starved Rock State Park (July 6), Urbana (Oct. 21, 28), 1929. Oviparous females taken at Urbana, October 21-28, 1929. Male at Oakwood on October 14, 1929.

In view of the limitations of the original description, a few descriptive details of the alate viviparous female are given, together with a description of the heretofore unrecorded apterous oviparous female.



Fig. 29. Curling leaves of blackberry, *Rubus*, caused by *Cerosiphia rubifolii* (Thomas); Oakwood, July 24, 1929.

ALATE VIVIPAROUS FEMALE

Thomas' original description may be emended as follows: Length, 1.12. Average width of head across eyes, .37. Comparative lengths of antennal segments as follows: III—.27, IV—.15, V—.11 plus .26. Secondary sensoria (Fig. 275) confined to third antennal segment, numbering from 2 to 7, averaging 4, rarely as few as 2 or as many as 7. Cornicles (Fig. 138) .16 long, straight. Cauda (Fig. 192) .08 long, not constricted, with about four hairs on a side. Second fork of media variable in position.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 1.14. General color throughout essentially similar to apterous viviparous female. Average width of head across eyes, .29. Comparative lengths of antennal segments as follows: III—.17 to .23, average .21; IV—.11 to .13, average .12; V—.09 to .10, average .09 plus .16 to .21, average .20. Antennal segments without secondary sensoria. Beak reaching to mesothoracic coxae. Cornicles .14 long, straight, imbricated, rim at apex poorly developed. Cauda .11 long, constricted near middle, with three hairs on a side. Hind tibiae only slightly swollen, with about 20 to 30 sensoria.

Neotype.—Alate viviparous female; Slide No. 4425, Albion, Illinois, May 26, 1928, on blackberry, (Frison and Hottes). On slide with alate and apterous viviparous females, pupae, and nymphs. Since this species was originally described from Illinois and the types are lost, a slide in the Survey collection has been selected as the *neotype*. *Morphotype*.—Apterous oviparous female: Slide No. 8424, Urbana, Illinois, October 28, 1929, on blackberry, (T. H. Frison). On slide with oviparous females and nymphs.

GENUS HYALOPTERUS KOCH

Key to the Species of the Genus Hyalopterus

1. Secondary sensoria present on fourth antennal segment (4-9).....2
- Secondary sensoria absent on fourth antennal segment, numbering from 8 to 14 on third.....*atriplicis* (Linnaeus) p. 231
2. Secondary sensoria present on fifth antennal segment (3-5), third segment with about 10-15, less than 20..*hyperici* (Monell) p. 232
- Secondary sensoria absent on fifth antennal segment, third segment with 20 to 40.....*pruni* (Geoffroy) p. 232

HYALOPTERUS ATRIPLICIS (LINNAEUS)

Aphis atriplicis Linnaeus, Fauna Svecica, Editio Altera, Auctior, Stockholm, 1761, p. 262.

This cosmopolitan species was first recorded from Carbondale, Illinois, by Monell (1879), who examined specimens sent to him by Thomas' assistant, Miss Middleton. Also previously reported from Illinois by Forbes (1900) and Davis (1910e). It causes a severe leaf curling or podlike folding of the leaves of goosefoot, or lamb's quarters. Hayhurst (1909) has given detailed descriptions of all the various forms and a general account of its biology.

Our records of viviparous specimens of this species are as follows: Antioch (June 15), Cairo (June 2), Carbondale (June 4), Danville (July 15), Elizabethtown (Oct. 12), El Paso (July 5), Galena (June 25), Havana (June 21), Kankakee (June 29), LeRoy (June 20), Oregon (June 27), Quincy (June 6), Rock Island (June 24), Shawneetown (May 27). Starved Rock State Park (June 13), 1928; Homer (June 17), Sparta (June 24), Urbana (May 26), 1929. All collected on *Chenopodium album*.

HYALOPTERUS HYPERICI (MONELL)

Aphis hyperici Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, 1879, Art. 1, p. 25.

Myzocallis hypeici Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 108. *New Synonymy*.

The types of *Myzocallis hypeici* Thomas (index indicates spelling of specific name was intended for *hyperici*) have recently been discovered, on Slides No. 2796 and 2797 in the Survey collection. Slide No. 2797 has been designated the *lectotype* and Slide No. 2796 the *paratype*. These have been compared with slides of *H. hyperici* (Monell) kindly loaned by Professor J. J. Davis. The species apparently belongs to the genus *Hyalopterus*. It has not been recorded from Illinois except by Thomas, the data with his specimens being: Carbondale, Illinois, in April, on *Hypericum prolificum*.

HYALOPTERUS PRUNI (GEOFFROY)

FIG. 199

Aphis pruni Geoffroy, Histoire abrégée des Insectes qui se trouvent aux environs de Paris, dans laquelle ces animaux sont rangés suivant un ordre méthodique. Paris, Durand, 1762, 2 Vols., p. 497. Published anonymously but known to be work of Geoffroy.

The proper specific name to use for this species, commonly referred to as the mealy plum aphid, is *pruni* Geoffroy (1762). Fabricius (1775) listed this species under two names, *arundinis* and *pruni*; the former having page priority and hence causing its use by recent writers. *Pruni*, however, should be used and credited to Geoffroy (1762) because Geoffroy first proposed it as a binomial name. Attention has been called to Geoffroy's use of *pruni* as a binomial by Hottes (1930a).

This enemy of plums and related fruits has been previously recorded from northern Illinois by Davis (1910e) under the name of *H. arundinis* Fabricius. A good account of its life history and habits is given by Davidson (1919). It is known to migrate, having spring and fall generations on plum, the leaves of which it causes to curl, and summer generations on *Phragmites*, *Typha*, and *Arundo*; or at times in certain localities to spend the entire year on plum. Like many other aphids of economic importance, it is reported from many parts of the world.

Data associated with viviparous specimens in the Survey collection are as follows: Antioch (Aug. 13), 1906, on *Phragmites*; Rock Island (July 7), and Urbana (June 25), 1929, both on *Prunus domestica*.

GENUS HYSTERONEURA DAVIS

HYSTERONEURA SETARIAE (THOMAS)

FIGS. 30, 89, 135, 283

Siphonophora setariae Thomas, Bulletin of the Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 5.

This brown plum aphid was described by Thomas from specimens collected at Carbondale, Illinois. Our records indicate that it is very



Fig. 30. Infestation of the rusty plum aphid, *Hysteroneura setariae* (Thomas), on the ornamental plum, *Prunus triloba*; Urbana, June 3, 1929.

widely distributed in the state. It over-winters on plum and in spring is often very abundant on the stems and leaves of the new growth (Fig. 30). Later it migrates to grasses and other plants upon which it spends the summer.

The cotypes of this species (Vial 40 of the Thomas collection) have recently been recovered and mounted on two slides in gum damar. Slide No. 7714 has been designated as the *lectotypic* slide and Slide No. 7715 as the *paratypic* slide. Both slides contain specimens of alate and apterous viviparous females. Data associated with these slides are as follows: on *Setaria glauca*, Carbondale, Illinois, August 16, 1877.

Data associated with our viviparous specimens are as follows: Normal Aug. 7), 1883; Duquoin (June 7), 1884; Odin (May 7), 1895; Urbana (October 29), 1901; Rockport (May 21), 1906; Lincoln (May 6), 1925; Albion (May 26), Carbondale (May 17, June 4-14), Centralia (Oct. 12), Elizabethtown (May 29-31), Herod (May 31), LeRoy (June 20), Metropolis (June 1), Mt. Carmel (May 26), Muncie (Oct. 6), Shawneetown (May 27), Urbana (May 23-24), 1928; Bondville (Sept. 26), Galena (July 10), Macomb (May 3), Olney (June 18), Oregon (July 11), Rock Island (July 7), Springfield (May 2), Urbana (June 1-17, July 24), 1929; Effingham (Nov. 13), Flora (Nov. 13), Metropolis (April 17) and Starved Rock State Park (May 13), 1930. Sexual forms and mating pairs were collected at Flora, November 13, 1930. Host records are as follows: *Melilotus alba*, *Prunus avium*, *Prunus domestica*, *Prunus persica*, *Prunus triloba*, *Prunus virginiana*, *Prunus* sp., *Setaria glauca*, and *Setaria viridis*.

GENUS RHOPALOSIPHUM KOCH

(SUBGENERA RHOPALOSIPHUM KOCH, HYADAPHIS KIRKALDY, AND LIOSOMAPHIS WALKER)

Key to the Species of the Genus *Rhopalosiphum*

1. Cornicles with apical portion much swollen and contrasting with narrow basal portion (Fig. 148).....2
- Cornicles approximately cylindrical (Fig. 134).....5
2. Terminal filament of sixth antennal segment about as long as basal portion.....*berberidis* (Kaltenbach) p. 235
- Terminal filament of sixth antennal segment over twice as long as basal portion.....3
3. Third antennal segment with more than 25 sensoria; fourth antennal segment with at least 5 sensoria..*melliferum* (Hottes) p. 238
- Third antennal segment with less than 25, usually about 15 sensoria; fourth antennal segment usually without sensoria, sometimes with one or two.....4
4. Hind tibiae about three times as long as width of head through the eyes; third antennal segment rarely with as many as ten secondary sensoria; cauda stout.....*rhois* Monell p. 240
- Hind tibiae about twice as long as width of head through the eyes; third antennal segment with more than ten secondary sensoria; cauda somewhat elongate....*nymphaeae* (Linnaeus) p. 238
5. Terminal filament of sixth antennal segment less or not more than twice as long as basal portion; basal portion about equal in length to the fifth antennal segment.....
-*rufomaculatum* (Wilson) p. 241
- Terminal filament of sixth antennal segment over twice as long as basal portion; basal portion not as long as fifth antennal segment6

6. Terminal filament of sixth antennal segment less than three times as long as basal portion; cornicles and hind tibiae usually of about the same thickness .*pseudobrassicæ* (Davis) p. 240
- Terminal filament of sixth antennal segment about four or more times as long as basal portion; cornicles usually wider than hind tibiae7
7. Abdomen essentially greenish.....*prunifoliae* (Fitch) p. 239
- Abdomen essentially brown.....*enigmæ* n. sp. p. 235

RHOPALOSIPHUM BERBERIDIS (KALTENBACH)

FIG. 148

Aphis berberidis Kalténbach, Monographie der Familien der Pflanzenläuse, Aachen, 1843, p. 95.

The barberry plant louse was first recorded from Illinois by Davis in 1908 and again in 1910 as "a common and often abundant species, occasionally in such numbers as to injure the barberry." It is a small yellowish form with the apterous forms predominating. According to our observations and those of others, it spends its entire life cycle on barberry. Detailed descriptions of all forms are given by Davis (1908c).

Data associated with our viviparous specimens are as follows: Antioch (June 15), Berwyn (June 14), Galena (June 25), Marshall (May 25), Mt. Carroll (June 25), Oregon (June 27), Urbana (Sept. 26, Oct. 19), 1928; Alton (June 25), Catlin (May 17), Effingham (June 18), El Paso (July 5), Starved Rock State Park (July 6), Urbana (May 8, Oct. 24), 1929. Males and oviparous females were collected at Urbana, October 24, 1929. All material taken on *Berberis Thunbergii minor*.

RHOPALOSIPHUM ENIGMAE new species

FIGS. 134, 200, 207, 262, 263

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.18. Head and thorax dark dusky brown. Abdomen varying in color from yellowish brown to dark reddish brown with slight indications of darker brown spots on the lateral margins. Cornicles, cauda, and anal plate dark dusky brown. Antennae dark dusky brown except extreme base of third segment and terminal filament of sixth, which are yellowish brown. Femora of all legs dark brown except for basal portions, which are yellowish or yellowish brown. Tibiae yellowish brown with a dark brown band at apex equal to length of tarsi; tarsi dark brown. Stigma of fore wings yellowish brown, veins of wings dusky, posterior margin of wings in vicinity of anal vein brown. Beak brown.

Head and appendages.—Vertex of head prominently pointed. Average width of head across eyes, .46. Antennal segments with the following comparative lengths: III—.33 to .36, average .34; IV—.19; V—.17; VI—.09 plus .50 to .57, average .53. Secondary sensoria (Fig. 262) confined to third and fourth antennal segments. Third segment with sensoria numbering from 7 to 11, averaging 9, arranged in an irregular row. Fourth segment usually with one or two secondary sensoria. Primary sensoria on sixth segment with a group of very small marginal sensoria. All segments of antennae imbricated. Beak comparatively short, failing to reach middle coxae by a considerable distance.

Thorax and appendages.—Prothorax with a pair of small finger-like lateral tubercles. Mesothorax with a pair of small wax glands on the

anterior ventro-lateral region. Stigma of fore wings rather sharply pointed; second fork of media extremely close to margin of wing when present; all veins ending in brownish suffusions.

Abdomen.—First abdominal segment and the segment posterior to cornicles with small lateral tubercles. Cornicles (Fig. 134) about .29 in length, only very slightly swollen, the swelling accentuated by the pronounced constriction just before the well-developed flange; entire surface distinctly imbricated. Cauda (Fig. 200) poorly developed, .12 in length, distinctly constricted near middle, with two hairs on each side. Anal plate about three times as wide at the base as the cauda, and with only a few hairs.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.26. Head, thorax, and abdomen concolorous, varying from dark reddish brown to greenish brown. Cauda, anal plate, cornicles, and beak dark brown. Antennae similar in color to those of alate viviparous female. Femora dark brown, paler at base; tibiae greenish yellow, their apices and the tarsi infuscated with brown.

Head and appendages.—Average width of head across eyes, .47. Antennal segments with the following comparative lengths: III—.27 to .33, average .31; IV—.17 to .23, average .20; V—.17 to .23, average .20; VI—.09 to .10, average .10 plus .46 to .57, average .50. All segments without secondary sensoria, distinctly imbricated, and with sparse hairs. Beak reaching just beyond mesothoracic coxae.

Thorax.—Prothorax with a pair of small lateral tubercles.

Abdomen.—Surface of abdomen reticulated and with a very few long, fine hairs. First segment and segment posterior to cornicles with minute lateral tubercles, similar tubercles occasionally seen on other segments. Cornicles similar in shape to those of alate viviparous female, averaging .45 in length. Cauda about .17 long, and little stouter than that of the alate viviparous female, with two hairs on each side, one side occasionally with three hairs. Anal plate normal.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.90. Color essentially similar to that of apterous viviparous female.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with the following comparative lengths: III—.19; IV—.11 to .13, average .12; V—.13; VI—.07 plus .29 to .46, average .37. Secondary sensoria absent. Third and fourth antennal segments with a decided tendency to remain united or to separate incompletely, and in many cases the antennae are but five-segmented. All segments of antennae imbricated. Beak reaching midway between pro- and mesothoracic coxae.

Thorax and appendages.—Prothorax with a large, well-developed pair of lateral tubercles. Hind tibiae with the basal half very slightly swollen, sensoria very pale and difficult to count.

Abdomen.—Six segments of the abdomen with very minute lateral tubercles. Cornicles about .28 long, otherwise similar to those of alate viviparous female. Cauda .11 in length (Fig. 207), with hairs on each side, very thick, and not constricted, in this respect unlike that of viviparous females. Anal plate normal.

ALATE MALE

Size and general color.—Length from vertex to tip of anal plate, 1.20. Color essentially similar to that of alate viviparous female.

Head and appendages.—Antennal segments with the following comparative lengths: III—.33; IV—.23; V—.21; VI—.09 plus .54. Secondary sensoria (Fig. 263) distributed as follows: III—17; IV—14; V—10; irregularly arranged and scattered over entire surface of segment. Primary sensorium of sixth antennal segment with a group of about five small marginal sensoria at one side. Antennae imbricated and with a few short hairs. Beak reaching to the mesothoracic coxae.

Thorax and appendages.—Prothorax with a pair of lateral tubercles. Wings and wing veins similar to those of alate viviparous female.

Abdomen.—Cornicles .24 long, otherwise similar to those of alate viviparous female.

NYPH

Nymphs of apterous and oviparous females usually with five-segmented antennae.

Holotype.—Alate viviparous female; Eldorado, Illinois, June 19, 1929, on *Typha latifolia*, (Frison and Hottes). On slide with four paratypic nymphs. Slide No. 10719. *Allotype*.—Alate male; Danville, Illinois, November 4, 1928, on *Typha latifolia*, (T. H. Frison). On slide with paratypic nymphs. Slide No. 10720. *Morphotype*.—Apterous viviparous female; Catlin, Illinois, May 17, 1929, on *Typha latifolia*, (Frison and Ross). On slide with paratypic apterous viviparous female and nymphs. Slide No. 10721. *Morphotype*.—Apterous oviparous female; same data as allotype. On slide with paratypic oviparous females and nymphs. Slide No. 10722. *Paratypes*.—Thirty-seven slides, containing alate and apterous viviparous females, oviparous females, a male, and nymphs, all collected in Illinois on cat-tail (*Typha latifolia*) by T. H. Frison, F. C. Hottes, and H. H. Ross, except one slide collected at Thompson's Lake, Havana, Illinois, August 11, 1896, on *Sparganium*, (Hart and Adams). The dates and localities are as follows: Carbondale (June 4), Centralia (Oct. 12), Danville (Nov. 4), Herod (May 31), Metropolis (June 1), and Quincy (June 6), 1928; Allerton (June 17), Catlin (May 17), Eldorado (June 19), Elizabethtown (June 20), Hardin (June 25), Maryville (Sept. 11), Oakwood (Oct. 17), and Seymour (June 12), 1929. Slides Nos. 4516-4521, 4524, 4535, 10723-10746 and others unnumbered.

This species is structurally very similar to *R. prunifoliae* (Fitch), from which it differs in color, being a deep reddish brown instead of green or greenish yellow. The few alate specimens of *R. enigmæ* in our possession differ from the usual condition found in *prunifoliae* in having only one or two sensoria on the fourth antennal segment. *Prunifoliae*, however, varies so greatly in respect to this character that it is not of practical use. This species was sent to Dr. Edith M. Patch for determination, and she considered it to be *R. nymphacæ* (L.), but it differs from the form we are considering as *R. nymphacæ* in a number of characters, especially in the length and shape of the cornicles. It should be noted that we have taken all forms on cat-tail and that specimens have been taken on this host in the spring before any migratory species in the same vicinity, so far as known, had left their overwintering hosts.

RHOPALOSIPHUM ENIGMÆ var. PARVÆ new variety

This variety is essentially like *R. enigmæ* new species, except that the antennae are only five-segmented, the cornicles shorter, and the lateral tubercles better developed. The average width of head across the eyes is .41. The comparative antennal measurements are as follows: III—.19 to .26, average .22; IV—.08 to .10, average .09; V—.07 plus .21 to .27, average .24. The cornicles average .15 in length.

Holotype.—Apterous viviparous female, Danville, Illinois, July 22, 1930, on *Carex*, collected by F. C. Hottes and O. E. Tauber. Slide No. 10642. *Paratypes*.—Twenty-one slides with same data as for holotype. Slides Nos. 10643-10656 and others unnumbered.

In view of the shorter cornicles and certain other slight differences, it has seemed inadvisable to group these specimens with

enigmae. Future collecting may prove *enigmae* to be a very variable species and that this new variety can be relegated to synonymy. On the other hand there is the possibility that the variety *parvae* may prove to be an entirely distinct species.

RHOPALOSIPHUM MELLIFERUM (HOTTES)

Aphis xylostei Schrank, Fauna Boica, Durchgedachte der in Baiern einheimischen und zahmen Thiere, 2 Bd., 1 Abt., Ingolstadt, 1801, p. 107. A homonym.

Hyadaphis mellifera Hottes, Proceedings of the Biological Society of Washington, Vol. 43, October 7, 1930, p. 184.

This cosmopolitan species migrates from honeysuckle, upon which it over-winters, to parsnip and a number of other summer hosts. Good descriptions of the viviparous forms are given by Theobald (1927) and some data regarding its biology by Gillette (1911b). We have seen two of the slides recorded as "*Hyadaphis pastinacae* Linn.?" from Illinois by Davis (1910e) and find them to be the species *Cavariella aegopodii* (Scopoli) and not this species, which is the *pastinacae* of some American authors.

Data associated with our viviparous specimens are as follows: Mt. Carmel (June), Normal (Aug. 18), 1884; Urbana (July 27), 1912 (Davis); Albion (May 25-26), Antioch (June 15), Cave-in-Rock (May 29-30), Champaign (May 17, July 26), Decatur (Nov. 4), Metropolis (May 30-31, June 1), Quincy (June 6), Starved Rock State Park (June 12), Urbana (May 23-28, June 7, Sept. 26, Oct. 1), 1928; Allerton (June 17), Alton (June 25), Catlin (May 17), Galena (June 10), Morriston (July 9), Oakwood (Oct. 14), Oregon (July 11), Rock Island (July 7), Seymour (Oct. 16), Starved Rock State Park (July 6), Urbana (May 26, June 3, July 2, Aug. 22), 1929. We have taken males at Seymour, October 16, and at Oakwood, October 14, 1929. Collected on *Carex* sp., *Conioselinum chinense*, *Cryptotaenia canadensis*, *Lonicera flava*, *Lonicera sempervirens*, *Lonicera* sp., and *Pastinaca sativa*.

RHOPALOSIPHUM NYMPHAEAE (LINNAEUS)

Aphis nymphaeae Linnaeus, Fauna Svecica, Editio Altera, Auctior, Stockholm, 1761, p. 260.

This cosmopolitan aphid is of more than ordinary interest because it attacks aquatic plants and at times leads almost a semi-aquatic existence. Patch (1915b) has demonstrated that the species is migratory, plum serving as the over-wintering host and aquatic plants as the summer host. The same type of life cycle is followed also in California, according to Davidson (1917). It occasionally spoils the appearance of aquatic plants in greenhouses and may injure the fruit of plums.

Davis (1910c) first recorded it from Illinois and proved that *aquaticus* Jackson (1908) was a synonym of *nymphaeae*. Jackson (1908), Patch (1912a), and Theobald (1927) have given good descriptions of the viviparous forms and male. Davidson (1917b) briefly mentions the oviparous females which are produced in autumn on plum. Our material agrees well with the description of the European form except that the secondary sensoria on the fourth antennal segments of alate forms consistently average fewer.

Data associated with our viviparous specimens are as follows: Havana (Sept. 14), 1894; Havana (July 21), 1897; Ottawa (July 20), 1901; Decatur (Oct. 20), Urbana (May 23), 1928; Cobden (June 21), Mt. Vernon (Sept. 26), Oakwood (Oct. 17), 1929; Evanston (March 12), 1930. Collected on *Nymphaea costaleifera*, *Nymphaea* sp., *Lemna trisulca*, *Potamogeton natans*, *Galium* sp., *Eichhornia* sp.

RHOPALOSIPHUM PRUNIFOLIAE (FITCH)

FIGS. 31, 196

Aphis prunifoliae Fitch, Transactions of the New York State Agricultural Society, Vol. XIV, 1854 (printed 1855), p. 826.

The apple-grain aphid was first reported from Illinois by Thomas in the *Prairie Farmer* for 1862 as *Aphis avenae* Fabricius. Because of its cornicles—somewhat intermediate between an aphid and a typical



Fig. 31. Leaves on hawthorn, *Crataegus*, curled by spring generations of the apple grain aphid, *Rhopalosiphum prunifoliae* (Fitch); Urbana, April 20, 1929.

Rhopalosiphum—this species is difficult to place generically. We are placing it in the genus *Rhopalosiphum* in accordance with present usage, although it has no more in common with species in this genus than with certain species of *Aphis*, the genus in which it was placed for many years. It is exceedingly abundant in Illinois in the spring of the year on *Crataegus* (Fig. 31) and on apple, from which it soon migrates to grasses and small grains to spend the summer months. The fact that this species leaves the apple early in the season lessens its importance as an apple pest.

Data associated with our viviparous specimens are as follows: Normal (June 21), 1883; Urbana (May 23, Aug. 9), 1885; Urbana (Oct. 27), 1886; Tonti (Oct. 14), 1887; Urbana (June 25), 1889; Normal (Nov. 16), 1894; Havana (Aug. 11), 1896; Peoria (Nov. 7), 1906; Beech Ridge (May 22),

1907; Carbondale (Oct. 13), 1926; Antioch (June 15), Carbondale (May 17, June 4), Decatur (Sept. 20, 29, Nov. 4), Herod (May 31), Marshall (May 25), Metropolis (June 1), Muncie (Oct. 6), Nelson (June 8), Quincy (June 6), Urbana (May 21, Oct. 9, 18, 19, Nov. 14), 1928; Lewistown (May 4), Macomb (May 3), Mahomet (April 3), Olney (June 18), Rantoul (April 24), Seymour (Oct. 30), Springfield (May 2), St. Joseph (April 12), Urbana (April 16, 17, 22, 24, May 9), Woodriver (May 20), 1929; Effingham (Nov. 13), Urbana (Nov. 19), 1930. Collected on *Avena sativa*, *Carex* sp., *Crataegus* sp., *Prunus japonica*, *Pyrus Malus*, *Pyrus* sp., and undertermined grasses.

RHOPALOSIPHUM PSEUDOBRASSICAE (DAVIS)

Aphis pseudobrassicae Davis, Canadian Entomologist, Vol. XLVI, July, 1914, p. 231, Figs. 21, 22.

Probably many of the previously published records of *Brevicoryne brassicae* Linn. from Illinois have reference to this species since it has been our experience that *pseudobrassicae* is by far the more common and destructive species attacking cabbage and cruciferous plants in the state. Only the viviparous forms have been described, and there is some question as to how the species over-winters in Illinois. In the original description Davis suggests that the viviparous females over-winter. Paddock (1915), who has studied this species in considerable detail in Texas, reports that in Texas it is not found on cultivated host plants from May until September, thus suggesting it has an alternate host during the hot summer months. It occurs throughout the state and often is a serious pest in spring and fall on cruciferous garden crops.

Data associated with our viviparous specimens are as follows: Cairo (June 3), Carbondale (June 4), Champaign (June 19), Decatur (Sept. 18), DesPlaines (July 6), Elizabethtown (May 29), Galena (June 25), Goleconda (Oct. 13), Harrisburg (May 28), Havana (June 21), Herod (May 31), Kankakee (June 29), Metropolis (May 31, June 1), Mt. Carroll (June 25), Oregon (June 27), Quincy (June 6), Urbana (Aug. 6), 1928; Cairo (June 21), Homer (June 17), Kansas (June 17), Oakwood (June 29), Starved Rock State Park (July 5, 6), 1929; Allendale (October 8), 1930. All our material has been collected on *Brassica oleracea*, *Brassica rapa*, *Raphanus sativus*, and *Lepidium virginicum*.

RHOPALOSIPHUM RHOIS MONELL

Rhopalosiphum rhois Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 27.

This large brown aphid is often very conspicuous because of its superabundance on the undersides of the leaves of sumach. In the early summer this species is reported to migrate to various grasses (Gillette, 1915) upon which it spends the remaining portion of the summer. We have collected it only on sumach (*Rhus glabra*). The summer generations of this aphid were described as a new species by Wilson (1911) under the name of *Amphorophora howardii*. Later Davis (1914a) redescribed in detail the viviparous forms and the male produced on wild and cultivated grasses. The latter author states, "Although careful search was made, we were unable to find oviparous females [produced on grasses]." Further he states, "It appears . . . that

the winged males and winged viviparous females migrate [from grasses] to an unknown host in the fall of the year, where the oviparous females are produced." We have found the oviparous female on sumach in fall. A description of the heretofore undescribed apterous oviparous female is presented.

Data associated with our viviparous specimens of this species are as follows: Dixon (July 29, 30), 1883; Champaign (July 18), 1884; Champaign (June 26), 1886; Champaign (July 31), East Peoria (July 22), Golconda (Oct. 13), Marshall (May 25), Metropolis (May 31), Mt. Carmel (May 26), Starved Rock State Park (June 13), Urbana (July 10, Aug. 2), 1928; Collinsville (Sept. 11), Elizabethtown (June 20), El Paso (July 5), Galena (July 10), Hardin (June 25), Kappa (July 5), Mounds (June 21), Mt. Carroll (July 9), Oregon (July 11), Richmond (July 12), Rock Island (July 7), 1929.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 1.34. General color essentially similar to apterous viviparous female. Average width of head across eyes, .34. Comparative lengths of antennal segments as follows: III—.30; IV—.16 to .17, average .17; V—.14; VI—.10 plus .30 to .36, average .34. Secondary sensoria absent. Primary sensorium on sixth antennal segment with about 5 marginal sensoria. Cornicles .36 long. Cauda .18 long, with about three strongly incurved hairs on a side. Hind tibiae considerably swollen, with about 130 sensoria.

Morphotype.—Apterous oviparous female; Slide No. 8135, Collinsville, Illinois, September 11, 1929, on *Rhus glabra*, (Frison and Ross). On slide with alate viviparous female and apterous oviparous females.

RHOPALOSIPHUM RUFOMACULATUM (WILSON)

Aphis rufomaculata Wilson, Entomological News, Vol. XIX, No. 6, June, 1908, p. 261.

This species was first reported from Illinois by Davis. Our records indicate that it is of considerable economic importance as a pest of chrysanthemums growing in greenhouses. None of our specimens were taken on chrysanthemum growing out of doors. This species is the genotype of *Coloradoa* Wilson which has been placed as a synonym of *Rhopalosiphum* by Baker (1920). There is some evidence, however, for retaining *Coloradoa* as a subgeneric name. Only the viviparous forms have apparently been described.

Data associated with our viviparous specimens are as follows: Carbonale (June 4), Chicago (June 14), Des Plaines (Dec. 18), Hutsonville (Nov. 28), Lawrenceville (Nov. 28), Urbana (May 23, June 6), 1928; Quincy (Nov. 6), 1930. Collected only on *Chrysanthemum* sp.

GENUS TOXOPTERA KOCH

TOXOPTERA GRAMINUM (RONDANI)

Aphis graminum Rondani, Nuovi annali delle scienze naturali. Bologna, Ser. 3, Vol. VI, 1852, p. 10.

The green bug, as it is referred to in the literature of economic entomology, has at times caused serious and widespread damage to wheat and oats in Illinois and many other states. It is of particular in-

terest to entomologists because of the marked epidemic character of its depredations, the epidemics depending mostly upon weather conditions. In normal years the excessive abundance of the green bug is held down by parasites. During long periods of cool, wet weather, however, when the temperature remains below 65°F. the rate of reproduction of the parasites is retarded whereas the green bug continues its normal rate of reproduction under temperatures running almost as low as 40°F. Sexual forms are produced in Illinois, but in the southern states the green bug breeds viviparously throughout the year.

There are numerous references to this species in literature, among which those by Hunter and Glenn (1909), Webster and Phillips (1912), and Theobald (1927) contain good descriptions of the various forms as well as giving much information regarding its biology.

Data associated with our viviparous specimens are as follows: Mt. Carmel (June 10), 1890; Beech Ridge (May 22), 1907; Homer (June 17), Rock Island (July 7), Seymour (June 13), 1929. Collected on *Avena sativa*, *Carex* sp., and *Triticum* sp.

SUPERTRIBE CALLIPTEREA

KEY TO GENERA

1. Eyes without ocular tubercles (Fig. 321).....2
- Eyes with ocular tubercles (Fig. 83).....5
2. Hind wing with longitudinal vein rarely forked more than once (Fig. 88); cauda constricted near middle and knob-like (Fig. 178); terminal filament much longer than greatest width of sixth segment (Fig. 242).....3
- Hind wing with longitudinal vein forked twice (Fig. 91); cauda not constricted but rounded (Fig. 216); terminal filament scarcely, if any, longer than greatest width of sixth segment (Fig. 244)**Stegophylla** p. 268
3. Body with peculiar modified setae (Fig. 316).....4
- Body with normal type of spine-like setae (Fig. 324).....**Thripsaphis** p. 270
4. Modified setae on margins of abdomen long and conspicuous; third antennal segment and hind tibiae about equal in length; veins of wings conspicuously outlined with fuscous....**Iziphya** p. 250
- Modified setae on margins of abdomen small and inconspicuous; third antennal segment much shorter than hind tibia; veins of wings not conspicuously outlined with fuscous....**Saltusaphis** p. 265
5. Terminal filament scarcely, if any, longer than greatest width of sixth segment (Fig. 244).....6
- Terminal filament much longer than greatest width of sixth segment (Fig. 266).....7
6. Cauda rounded (Fig. 216); third antennal segment with ten or more narrow and transverse secondary sensoria, fourth segment with a few sensoria.....**Tamalia** p. 268
- Cauda knobbed (Fig. 211); third antennal segment with less than ten secondary sensoria which are almost circular in shape, fourth segment without sensoria.....**Phyllaphis** p. 264
7. Conspicuous tubercles on dorsum of anterior abdominal segments (Fig. 327).....8
- Tubercles on dorsum of anterior abdominal segments wanting or very rudimentary10

8. Terminal filament of sixth antennal segment at least three or four times as long as basal portion of same segment (Fig. 243); cornicles moderately long and prominent (Fig. 154); anal plate slightly indented (Fig. 217).....**Drepanaphis** p. 246
- Terminal filament of sixth antennal segment at most twice as long as basal portion of same segment (Fig. 247); cornicles short and somewhat trapezoidal (Fig. 156); anal plate deeply indented (Fig. 168).....9
9. Abdomen with well-developed lateral tubercles (Fig. 310) in addition to those on dorsum.....**Melanocallis** p. 251
- Abdomen without lateral tubercles.....**Tuberculatus** p. 271
10. Cauda elongate and spatulate-shaped beyond constriction (Fig. 183) **Cepegillettea** p. 246
- Cauda knob-like beyond constriction.....11
11. Fore femora with a projection or tubercle near distal end (Fig. 325) **Shenahweum** n. gen. p. 267
- Fore femora without a projection or tubercle near distal end (Fig. 326)12
12. Cornicles very short, not produced, almost ring-like (Fig. 155).....**Monellia** p. 252
- Cornicles distinctly produced, short or of medium length but never almost ring-like (Fig. 150).....13
13. Mesal apex of antennal tubercle protruding much beyond vertex (Fig. 78)14
- Mesal apex of antennal tubercle not or scarcely protruding beyond vertex (Fig. 81).....15
14. Radial sector well-developed (Fig. 72); anal and cubital veins of fore wings not margined with fuscous (Fig. 72); anal plate entire or nearly so (Fig. 173).....**Euceraphis** p. 249
- Radial sector lacking (Fig. 65) or partly developed (Fig. 57), except that in some specimens of *C. castaneae* it is entirely but weakly developed; anal and cubital veins of fore wings distinctly margined with fuscous (Fig. 57); anal plate somewhat bilobed or cleft (Fig. 220).....**Calaphis** p. 243
15. Cauda lengthened, constricted and with apex knob-like (Fig. 178) **Myzocallis** p. 254
- Cauda not distinctly constricted and more rounded (Fig. 211).....**Neosymydobius** p. 261

GENUS CALAPHIS WALSH

Key to the Species of the Genus Calaphis

1. Dorsum of thorax with one median and two lateral dark stripes **betulella** Walsh p. 244
- Dorsum of thorax without dark stripes.....2
2. Fourth and fifth antennal segments uniformly dark-colored, third antennal segments with about eight round sensoria (Fig. 235); on chestnut.....**castaneae** (Fitch) p. 245
- Fourth and fifth antennal segments with basal portions light and apical portions dark, third antennal segment with about twelve to eighteen oval sensoria (Fig. 236); on birch.....**betulaecolens** (Fitch) p. 244

CALAPHIS BETULAECOLENS (FITCH)

FIGS. 9, 11, 236

Aphis betulaecolens Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 66.

Davis (1909b) first reported the taking of this species in Illinois, saying "it doubtless occurs [in Illinois] wherever the birch is found." Our collecting indicates it is common in the northern part of the state, where the white birch, its host, is native, and that it is likely to be found wherever there are trees of this species. All of the various forms have been previously described in detail, particularly by Davis (1909b) and Baker (1916d). At times this species is abundant at Urbana and the eggs form regular masses (Fig. 9) on the low branches and watersprouts of its host. The lack of apterous viviparous females, or at least their rarity, is a feature in the life history of this species, and that of the next two following species, which differs from that of certain other closely related genera.

Data associated with our alate viviparous specimens, pupae, and nymphs are as follows: East Dubuque (June 25), Galena (June 25), Urbana (July 10), 1928; Beach (Aug. 29), Macomb (May 3), Savanna (July 9), Urbana (Aug. 20), Waukegan (July 13), 1929. Males and oviparous females have been taken at Decatur (Oct. 7) and Urbana (Oct. 15), 1929. All specimens collected on white or canoe birch, *Betula alba* var. *papyrifera*.

CALAPHIS BETULELLA WALSH

FIGS. 65, 78, 220

Calaphis betulella Walsh, Proceedings of the Entomological Society of Philadelphia, Vol. I, December, 1862, p. 301.

This large and handsome species of plant louse was originally described by Walsh from specimens taken in August on *Betula nigra* at Rock Island, Illinois. Since then it has not been recorded from the state, but our survey has shown that it is common from May to September in all parts of Illinois on the red or river birch (*Betula nigra*). This agile species preferably frequents the undersides of the succulent leaves. Baker (1916d) gives further details of the structural characters of the alate viviparous females.

Our collection records for alate viviparous females, pupae, and nymphs of this species are as follows: Cairo (June 2), Carbondale (June 4), East Dubuque (June 25), Harrisburg (May 28), Herod (May 29), Kankakee (June 29), Metropolis (May 31), Quincy (June 6), Rock Island (June 24), Urbana (Sept. 22), 1928; Hardin (June 25), Macomb (May 4), Pinckneyville (June 25), 1929; Urbana (Sept. 28), 1930. *Betula nigra* is the preferred host, but at times specimens were taken on other species of trees of this same genus.

Neotypic Slide.—Since this species was originally described from Rock Island, Illinois, by Walsh and the types are lost, a slide in the Survey Collection is selected as the *neotype*. The data associated with this slide are as follows: Slide No. 4657, Rock Island, Illinois, June 24, 1928, on *Betula nigra*, collected by T. H. Frison and F. C. Hottes.

CALAPHIS CASTANEAE (FITCH)

FIG. 57, 235

Callipterus castaneae Fitch, Transactions of the New York State Agricultural Society, Vol. XVI, 1856, p. 471. [Third Report on the Noxious and Other Insects of the State of New York, 1856, p. 471].

Not previously recorded from Illinois. Found by the writers on specimen trees of *Castanea dentata* in southern and central Illinois. Baker (1916d) has presented information regarding the typic specimens of Fitch and further details concerning characters of alate viviparous females. Descriptions are presented of the heretofore undescribed sexual forms.

Data associated with our specimens of alate viviparous females, pupae, and nymphs of this species are as follows: Decatur (Oct. 20), Urbana (July 1), 1928; Carbondale (June 21), Grayville (June 19), 1929. Oviparous females taken at Decatur (Oct. 20), 1928, and males and oviparous females taken at Urbana (Oct. 14), 1929. All taken on the under sides of leaves of host.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.50. Head dusky brown; prothorax dusky brown on dorso-meson, remaining portion yellowish; meso- and metathorax dusky brown on dorsum, yellowish laterally; abdomen uniform pale yellowish, including cornicles, cauda, and anal plate; genitalia brownish. Femora yellowish except for slightly brownish areas on dorsum near apex; tibiae and tarsi uniformly dark brownish black. First and second antennal segments and extreme base of third antennal segment concolorous with head, remaining segments brown. Stigma with posterior margin brown, remaining portion smoke-color, extreme basal portion with a much darker brownish spot. Anal and cubital veins much darker than media, with brownish borders. Beak yellowish with terminal portion brownish.

Structure.—Average width of head across eyes, .46. Comparative length of antennal segments as follows: III—.86 to .93, average .89; IV—.56 to .57, average .56; V—.40 to .46, average .43; VI—.17 to .23, average .19 plus .36 to .43, average .40. Secondary sensoria present on third, fourth, fifth, and sixth antennal segments; on the third and fourth segments widely scattered, covering the entire segment; on the fifth and sixth more frequently confined to an irregular row. Beak scarcely reaching midway between first and second pair of coxae. Second fork of media considerably closer to first fork than to margin of wing. Radial sector absent for part of its length. Cornicles .07 long. Cauda .08 long, with a well-developed knob-like structure at the tip.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length, 2.10. Head reddish brown; pro- and mesothorax dusky greenish brown; metathorax and abdomen yellowish green, dorsum anterior to cornicles with segmentally arranged transverse greenish brown strips and subquadrate lateral spots, all of which merge for three or four segments to form a brown patch immediately in front of cornicles. Segments posterior to the cornicles yellowish green. Cornicles and cauda dusky. Legs and antennae same color as in alate male.

Structure.—Average width of head across eyes, .41. Comparative average lengths of antennal segments as follows: III—.82; IV—.46; V—.40; VI—base .21, with no measurements for the terminal filament. Antennae usually without secondary sensoria, rarely third segment with one. Cornicles as in alate male, .10 long. Hind tibiae much swollen and with from 30 to 90 sensoria, usually more than 60. Distance between tip of ovipositor and cornicles, .46.

Allotype.—Alate male; Slide No. 8386, Urbana, Illinois, October 14, 1929, on *Castanea dentata*, (Frison and Park). *Morphotype.*—Apterous oviparous female; Slide No. 8383, same data as allotype.

GENUS CEPEGILLETTEA GRANOVSKY

CEPEGILLETTEA BETULAEFOLIAE GRANOVSKY

FIGS. 183, 326

Cepegillettea betulaefoliae Granovsky, Proceedings of the Entomological Society of Washington, Vol. 30, No. 7, October, 1928, p. 115.

This recently described species was collected in Illinois and recognized as distinct previous to its description by Granovsky. It is highly probable that it is restricted in distribution in Illinois to the extreme northeastern part of the state. Although it is recorded from *Betula alba* var. *papyrifera* by its describer, we have found it only on a dwarf birch, *Betula pumila*. Granovsky gives excellent descriptions of all forms of this species. His material was from Wisconsin and British Columbia.

Our specimens were collected at Antioch, June 15, 1928, and at Beach, Aug. 29, 1929.

GENUS DREPANAPHIS DEL GUERCIO

The treatment of this genus was prepared with the collaboration of Dr. A. A. Granovsky. His description of a new species is included without change. His measurements of antennal segments are expressed in comparative terms, not in millimeters.

Key to the Species of the Genus Drepanaphis

1. Species with more than one pair of prominent finger-like tubercles on dorsum of anterior abdominal segments (Fig. 327)....
..... *acerifoliae* (Thomas) p. 246
- Species with only one pair of prominent tubercles on dorsum of anterior abdominal segments and these united at the base (Fig. 323) 2
2. Wing veins broadly bordered with fuscous; only a single pair of prominent tubercles on dorsum of anterior abdominal segments.....*keshenae* Granovsky n. sp. p. 248
- Only the tips of veins marked by light brown flecks; single large or prominent pair of tubercles and occasionally two additional pairs of minute on dorsum of anterior abdominal segments....
..... *monelli* (Davis) p. 249

DREPANAPHIS ACERIFOLIAE (THOMAS)

FIGS. 154, 217, 243, 327

Siphonophora acerifoliae Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 4.

This species spends the entire year on its host. It appears early in spring and produces the sexual forms in the autumn. The eggs are laid in almost any protected place on the limbs and trunk. We are not aware of the production of apterous viviparous females. Davis (1910d) reports the species as "common throughout the state on soft maple and occasionally on hard and Norway maple but seldom in such numbers as

to be injurious." At Urbana in late summer or fall this species sometimes becomes a nuisance, the walks beneath infested trees being kept damp by the falling of honeydew. The alate viviparous females have been described and figured by several (Sanborn, 1904, and Patch, 1923b). Descriptions of the apterous oviparous female and male have apparently not appeared in literature and hence are given here.

Cotypes of this common species, which inhabits the undersides of the leaves of maple trees, were included among the recently discovered typical specimens of Thomas in the Survey collection. These cotypes have been mounted in damar balsam on two slides. Slide No. 7168 has been designated as the *lectotypic* slide and Slide No. 7169 as a *paratypic* slide. Both slides contain alate viviparous females and pupae in poor condition. The original vial containing these specimens was given the number 59 by Thomas. The data associated with the typic slides are as follows: Ft. Dodge, Iowa; Dubuque, Iowa; and Peoria, Illinois; September 1, 1877.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of anal plate, 2.18. General color yellowish suffused with light dusky brown. Antennae dusky brown, terminal filament and base of third segment lighter in color. Femora yellowish brown, tibiae either uniform brownish or with the basal portion darker than the apical portion; tarsi light dusky. Average width of head across eyes, .57. Antennae with the following comparative lengths: III—.57 to .69, average .61; IV—.36 to .46, average .42; V—.43 to .53, average .47; VI—.10 to .14, average .13 plus .43 to .53, average .48. Secondary sensoria absent. Beak reaches to mesothoracic coxae. Dorsum of abdomen without tubercles. Cornicles .18 long, with just a suggestion of a swelling at one side near the base. Posterior extremity of abdomen with a very elongate ovipositor. Anal plate and cauda rounded. Cauda .08 long, not longer than it is wide at base. Hairs on body enlarged at the tip. Hind tibiae very slightly swollen, with about 50 sensoria, mostly on one side, of the basal three-fourths of the segment.

Morphotype.—Apterous oviparous female; Slide No. 8423, Urbana, Illinois, October 9, 1929, on *Acer saccharinum*, (T. H. Frison). On slide with other oviparous females.

ALATE MALE

Length from vertex to tip of anal plate, 1.09. Width of head across eyes, .54. Color essentially as in alate viviparous female. Wings with veins, except bases, distinctly bordered with fuscous. Abdomen with a lateral row of quadrate brown spots and a median, dorsal brown stripe separating into small spots towards apex. Venter of abdomen with a median brown stripe terminating in the gonapophyses, which are also brown.

Average comparative antennal lengths as follows: III—.89, IV—.59, V—.56, VI—.14 plus 1.00. Secondary sensoria present on all antennal segments, numbering as follows: III—71 to 98, average 83; IV—34 to 55, average 43; V—15 to 29, average 20; VI—0 to 2, average 1. Dorsal tubercles of abdomen prominent, much as in alate viviparous female (Fig. 327), but with the first two small pairs reduced or absent. Cornicles .28 in length, mesal margin more or less straight, outer margin often greatly flared out at base, base wide. Cauda and anal plate as in alate viviparous female.

Allotype.—Alate male; Slide No. 8414, Metropolis, Illinois, September 28, 1929, on *Acer saccharinum*, (Frison and Hottes). On slide with nymph.

A series of specimens in which the veins of the front wings are not margined with fuscous except at the extreme apices, differ from the above description only in having the cornicles shorter, averaging .20 in length, and less swollen at the base.

Data associated with our Illinois specimens are as follows: Normal (May 10-15), 1884; Springfield (July 1), 1885; Urbana (June 24), 1887; Tonti (May 10), 1888; Urbana (Oct. 28, 1897; Albion (May 26), Cairo (June 2), Carbondale (June 4), Catlin (Sept. 27), Danville (Sept. 18),

Elizabethtown (May 29), Golconda (Oct. 13), Havana (June 21), Kankakee (June 29), Leroy (June 20), Marshall (May 25), Mattoon (June 10), Metropolis (May 31), Mt. Carmel (May 26), Mt. Carroll (June 25), Oregon (June 27), Pekin (June 20), Quincy (June 6), Shawneetown (May 27), Starved Rock State Park (June 12), Urbana (May 16, June 6-7, Oct. 25), 1928; Alton (June 25), Edwardsville (Sept. 11), Elizabethtown (June 20), Grayville (June 19), Herod (Sept. 27), Macomb (May 3), Metropolis (Sept. 28, Oct. 7), Newton (June 17), Rock Island (July 7), Springfield (May 2), Urbana (Oct. 7-9), 1929. Collected on *Acer saccharinum* and *Acer saccharum*. Sexual forms and mating pairs collected at Urbana in October.

DREPANAPHIS KESHENAE GRANOVSKY new species

ALATE VIVIPAROUS FEMALE

Length of body from frons to the tip of cauda about 2.084. General color is light brown or tan with yellowish undertone. The entire body is somewhat heavily covered with the white, waxy, flocculent secretion. This secretion is especially heavy along the dorso-medial line of the prothorax, thorax and abdomen. The first two anterior abdominal segments and the transverse area just back of the cornicles, as well as the lateral abdominal tubercles, are also covered with heavy wax. The dorsal tubercles and the areas around the cornicles are free from waxy threads, and only slightly dusted with a gray powder of waxy secretion. Head dusky brown with black circles around ocelli; posterior margin of the head with a distinct narrow black line, extending from eye to eye. Frons provided with a few fine hairs. Eyes large, carmine. Antennae placed on prominent diverging tubercles. Length of antenna—4.34. Comparative average lengths of antennal segments as follows:— I— 7.50; II— 3.00; III— .5678; IV— 40.64; V— 39.83; VI— 9.25 plus unguis 91.00. Antennal segment I dusky brown; segment II yellowish orange; segments III to VI orange to light brown with very narrow black annulations at distal ends. Base of the segment VI short, dusky brown. Unguis long, dusky. Antennae distally imbricated and provided with a few short, fine setae. The basal three-fifths or two-thirds of antennal segment III carries from 12 to 15 rather large, circular, secondary sensoria. The primary circular sensorium at the end of the segment V and the long oval sensorium at the base of the unguis are fringed with long sensilia in a form of crown; the latter sensorium is surrounded with a crowded row of auxiliary sensoria and two additional circular sensoria, each placed singly some distance from its poles of longitudinal axis. Rostrum not quite reaching to the second pair of coxae.

Thorax dark brown; thoracic lobes prominent, occasionally almost black. Legs pale yellow, clothed with fine hairs. Fore femora dark brown to dusky black; hind femora slightly dusky with dark brown to black bands at distal ends; middle femora the lightest in color, without such bands. All tibiae dusky brown at proximal ends and to a lesser extent distally, the middle tibiae being the lightest. All tarsi slightly dusky. Wings hyaline. Costa and subcosta of the fore wings yellow with brown or dusky areas near anal veins. Stigma heavily bordered with dusky brown, leaving the yellow oblong cell in the middle, which touches the outer margin of the stigma. Radial sector deeply curved. Media twice-branched. All veins, with the exception of costa and subcosta, are broadly banded with dusky brown, especially toward the tip of each vein, while bases of the media and cubitus are lighter and almost free from dusky borders. Hind wings with media and cubitus present, although latter only faintly indicated; media, distal end of costa, and areas near hamuli bordered with dusky brown.

Abdomen yellowish olive green to light brown, sparsely clothed with fine hairs. Lateral tubercles small, each bearing a single hair and usually dusky, especially on third, fourth, and fifth abdominal segments. The dorsum of the third abdominal segment is provided with a pair of black finger-like tubercles, united from the upper third to the base. The average length of the entire tubercle is 0.37; the width of the base 0.27; the height of the

united base 0.24; and the length of the finger-like processes 0.12. Cornicles dark dusky brown, almost black, having bowling-pin shape, paler and somewhat constricted at the base, and with a narrow pale flange at the distal ends. The average length of the cornicle 0.23; the width at the base 0.09; the width of the narrow neck 0.05. The abdominal area between the dorsal tubercles and the cornicles often with four rows of small dusky tubercular spots; these are often inconspicuous and faint. Cauda yellow, short, globular on a conical base with several long hairs. Anal plate yellow, slightly dented, hairy.

Host plant and feeding habits. Hard maple (*Acer saccharum*), feeding singly on lower side of the young leaves. Adults are quite active and often leap when foliage is only slightly disturbed.

Described from 7 alate viviparous females collected by A. A. Granovsky, September 14, 1927, at Keshena, Wisconsin, in virgin forest, and 9 specimens taken by T. H. Frison and F. C. Hottes, June 20, 1929, at Elizabethtown, Illinois.

Type locality. Keshena, Wisconsin, and Elizabethtown, Illinois.

Cotypes in the collections of the U. S. National Museum, Illinois State Natural History Survey (Slide Nos. 7616-7617), and in the private collection of A. A. Granovsky.

DREPANAPHIS MONELLI (DAVIS)

FIG. 323

Phymatosiphum monelli Davis, Annals of the Entomological Society of America, Vol. II, No. 3, Sept., 1909, p. 197.

This species is here recorded from Illinois for the first time. Our specimens were collected from the undersides of the leaves of hard maple and buckeye. The sexual forms have not been described.

A lectotypic slide (3119) was selected from cotypic slides of this species by Frison (1927).

Data associated with our viviparous specimens, all collected on *Acer saccharum* and *Aesculus glabra*, are as follows: Havana (June 21), Kankakee (June 29), Mt. Carroll (June 25), Oakwood (July 8), Urbana (May 16, June 7), 1928; Rock Island (July 9), 1929; and Urbana (July 23), 1930.

GENUS EUCERAPHIS WALKER

EUCERAPHIS BETULAE (LINNAEUS)

FIGS. 10, 72, 173

Aphis betulae Linnaeus, Systema Naturae, Editio Decima, 1758, p. 452.

This is the first record of the occurrence of this species in Illinois. It was collected on native white, or canoe, birch (*Betula alba* var. *papyrifera*) in the northwestern part of the state. Records in literature, ranging in North America from Connecticut to California and Europe, indicate that *betulae* is likely to be found wherever its host grows as a native tree. Good descriptions of the alate viviparous female and sexual forms have been given by Theobald (1927). Baker (1917b) has shown that *cerasicolens* (Fitch) is a synonym of *betulae* and has presented a key for the recognition of most of the American species belonging to this genus.

Data associated with our specimens of this species are as follows: East Dubuque (June 25) and Galena (June 25), 1928.

GENUS IZIPHYA NEVSKY

IZIPHYA FLABELLA (SANBORN)

FIG. 316

Chaitophorus flabellus Sanborn, Kansas University Science Bulletin, Vol. III, No. 1, July, 1904, p. 37.

This species has not previously been reported from Illinois. It is most easily taken by sweeping *Carex*, the host genus to which, according to published records and our collecting, it is confined. Originally described from Kansas and reported since from Colorado. Gillette (1909b) has given good descriptions and illustrations of the alate and apterous viviparous females.

Data associated with our specimens are as follows: Beach (Aug. 30), Carbondale (June 21), Grayville (June 19), Seymour (June 26, July 20), 1929.

GENUS MELANOCALLIS OESTLUND

MELANOCALLIS FUMIPENNELLA (FITCH)

Aphis fumipennella Fitch, Transactions of the New York State Agricultural Society, Vol. XIV, 1854 (printed 1855), p. 870.

Davis (1910b) described this species as new from material collected at Lake Forest, Illinois, under the name *Callipterus caryacfoliae*. Baker (1917b), on the basis of a study of Fitch's type, declared the species described by Davis a synonym of *Melanocallis fumipennella* (Fitch). Fitch's original description, however, fails to agree in some respects with specimens we are calling this species. This minute and very active black aphid was collected on the under surface of leaves of *Carya* sp. One of the cotypic slides of *caryacfoliae* Davis was designated as the *lectotypic* slide, No. 1838, by Frison (1927). Descriptions of the sexual forms, heretofore undescribed, are presented.

Data associated with our specimens are as follows: Mt. Carmel (May 27), 1884; Lake Forest (June 24), 1909; Danville (Sept. 18), Havana (June 21), Marshall (May 25), Metropolis (June 1), Mt. Carmel (May 26), Mt. Carroll (June 25), Shawneetown (May 27), 1928.

ALATE MALE

Length from vertex to tip of anal plate, 1.16. Color essentially that of alate viviparous female. Average width of head across eyes, .50. Comparative lengths of antennal segments as follows: III—.49, IV—.26, V—.24, VI—.14 plus .10. Secondary sensoria (Fig. 234) distributed as follows: III—60, IV—24, V—17, VI—7, irregularly arranged and scattered over entire surface of segments. Wings, legs, cornicles, cauda, anal plate, and tubercles similar to those found on alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of anal plate, 1.43. Head dusky brownish, thorax and abdomen light brownish with dark brown spots on dorsum and lateral portions, spots on middle of dorsum of abdomen often confluent and forming stripes. Cornicles and area around their base brown; no brownish

marking posterior to cornicles. Average width of head across eyes, .39. Comparative lengths of antennae as follows: III—.36; IV—.16; V—.17; VI—.11 plus .10. Secondary sensoria absent. Ovipositor elongate. Hind tibiae scarcely swollen, with about 35 sensoria. Dorsum and lateral portions of abdomen without tubercles. Hairs on body very elongate and with enlarged tips.

Allotype.—Alate male; Seven Hills, Alabama, October 24, 1928, on *Carya illinoensis*, (L. L. English). Slide No. 10570. *Morphotype*.—Apterous oviparous female; on same slide as allotype, together with another male and two alate viviparous females.

GENUS MONELLIA OESTLUND

The key to the species belonging to this genus and the description of a new species were prepared by Dr. A. A. Granovsky, and the identification of all Illinois material has been checked by him. His measurements of antennal segments are expressed in comparative terms, not in millimeters.

Key to the Species of the Genus *Monellia*

1. Costal margin of wing with broad black band intercepted before stigma..... *costalis* (Fitch) p. 252
- Costal margin clear or yellowish without black band.....2
2. Abdomen without brown or black maculation; terminal filament about equal to or only very slightly shorter than the basal portion of the sixth antennal segment; anal veins narrow and delicate; wings at rest held in flat position...*caryella* (Fitch) p. 252
- Abdomen usually with brown or black maculation with the exception of early summer forms, which have abdomen without such maculations, but then antennae and wings typical of the species; anal veins prominent, somewhat dusky; wings at rest held in erect position.....3
3. Abdomen usually with four rows of large brown or black spots most conspicuous on anterior segments; spring forms without such spots; terminal filament usually longer than, or seldom equal to, the basal portion of the sixth antennal segment....
- Abdomen usually with two very prominent black spots near the cornicles; spring forms without such spots; fall forms with six or eight rows of small spots over the dorsum; terminal filament usually shorter than and seldom equal to the basal portion of the sixth antennal segment.....
- *nigropunctata* Granovsky n. sp. p. 252

MONELLIA CARYAE (MONELL)

Callipterus caryae Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 31.

Davis (1910d) has previously recorded the American walnut aphid as "occurring everywhere throughout the state on hickory and walnut." It frequents the lower surfaces of the leaves and holds the wings erect while resting. Davidson (1911b) has given detailed descriptions of all forms and presented much information concerning the life history of this species as he found it in California on walnut. Davidson

failed to find, during eighteen months of study, any trace of wingless viviparous females.

Data associated with our viviparous specimens are as follows: Mt. Carmel (May 27), 1884; Danville (Sept. 18), Kankakee (June 29, July 15), Mt. Carmel (May 26), St. Joseph (Aug. 5), 1928; Bloomington (July 5), Edwardsville (Sept. 11), Galena (July 10), Hardin (June 25), Kansas (June 17), Rock Island (July 7), 1929. An oviparous female was collected at Edwardsville, Sept. 11, 1929. All specimens taken on *Carya* sp., *Juglans nigra*, *Juglans* sp., and *Quercus* sp.

MONELLIA CARYELLA (FITCH)

Fig. 157

Aphis caryella Fitch, Transactions of the New York State Agricultural Society, Vol XIV, 1854 (printed 1855), p. 867.

The little hickory aphid was first recorded from Illinois by Davis (1910d), who states, "I have collected this species but once, namely, on hickory at Centralia, Ill., August 13, 1907." In the field it may be separated from *M. caryae* and *M. nigropunctata* by the fact that the wings are held when at rest in a flat position over the body. Davidson (1914b) has published much information concerning the biology of this species and given technical descriptions of all the forms. He reports that the viviparous forms, so far as observed, all develop wings.

Data associated with our viviparous specimens from Illinois, all collected on *Carya ovata*, *Carya* sp., or *Juglans* sp., are as follows: Antioch (June 15), Mt. Carroll (June 25), Shawneetown (May 27), 1928; Columbia (Sept. 11), Elizabethtown (June 20), Grayville (June 19), 1929.

MONELLIA COSTALIS (FITCH)

Figs. 155, 251

Aphis caryella var. *costalis* Fitch, Transactions of the New York State Agricultural Society, Vol. XIV, 1854 (printed 1855), p. 869.

This species has not been previously recorded from Illinois. It is easily recognized because of the dark band on the costal margin of the fore wing. Baker (1917b) has redescribed the alate viviparous female but the sexual forms are apparently unknown or at least not described.

Data associated with our viviparous specimens are as follows: Mt. Carroll (June 25), Oregon (June 28), 1928; Cairo (June 22), Elizabethtown (June 20), Grayville (June 19), 1929. All specimens collected on *Carya ovata*, *Carya* sp., and *Juglans nigra*.

MONELLIA NIGROPUNCTATA GRANOVSKY new species

ALATE VIVIPAROUS FEMALE

Length of body from frons to the tip of cauda about 1.71. General body color from pale lemon yellow to orange or deep butter yellow with greenish tinge. Head concolorous with the body; frontal lobes may be slightly dusky about ocelli with a few singly placed bristles. Eyes bright red. Antennae on very small frontal tubercles, each of which is marked with a thin black line on lower edge of the antennal socket, nearly as long

as the width of the first antennal segment, slightly thicker at the outer end. Length of antenna 1.19. Comparative average lengths of antennal segments as follows: I— 3.2; II— 3.0; III— 22.10; IV— 12.78; V— 12.43; VI— 8.04 plus unguis 6.77. Unguis dusky, usually shorter than the base of the sixth segment. Antennae pale to pale yellow with dark brown to black annulations at distal ends of segments II to VI, inclusive; irregular slightly dusky shading over the sensorated area of segment III usually present. The entire antennae, with the exception of segments I and II, finely imbricated, more conspicuously distad of each segment. Antennae almost naked or with a few extremely minute setae. The tip of the unguis carries a few capitate hairs. The basal three fifths or more of segment III with a row of from 4 to 8, usually 5 to 7, rather large, oval, secondary sensoria. Only rarely some individuals have more and as many as 11 sensoria, covering almost the entire segment III. Segment V with a circular primary sensorium, and the usual primary oval sensorium with a few auxiliary ones at the base of the unguis. Both primary sensoria provided with fine fringes of short sensory hairs, especially at the base of each sensorium. Rostrum with its dusky tip barely reaches beyond the first pair of coxae.

Thorax deep orange, occasionally with dusky tinge. Each lateral margin of prothorax is marked with a dark brown or black line, extending from the head margin to half or two-thirds of the length of the prothorax, fading caudad. Legs pale yellow, sparsely clothed with short fine hairs. Distal ends of pro- and meta-femora on inner side marked with black conspicuous patches. Meso-femora without such patches. All femora and tibiae very slightly dusky distad. All tarsi dusky. Wings hyaline. Fore wings with costa and subcosta pale yellow; stigma deeper yellow with brownish margins, especially along the radial vein, and with a conspicuous dusky patch at the base. Radial sector short, nearly obsolete or very faintly indicated distally. Media twice-branched, brown at the base, color fading to the tips of the branches. Cubitus dark brown at the base, intensity of the color diminishing distally. Anal vein dark brown with diffused shading. Cubitus and anal veins conspicuously curved at their bases. Hind wings with media and cubitus present. Wings when at rest are held in upright position.

Abdomen from pale yellow to orange yellow normally with an oval, black or dark brown blotch, placed on each side, somewhat in front of the middle of the fifth abdominal segment, each with a clear hair tubercle in the middle. These blotches from dorsal and ventral sides may appear as heavy lines. They are often lacking on early spring forms, or they may be only faintly indicated. Late summer and fall forms almost without exception have dorsum of the abdomen speckled with from six to eight rows of small dark brown or dusky tubercles, each bearing very small fine hair. Lateral tubercles small and usually without maculations. Cornicles reduced to pore-like chitinized rings, back of the black abdominal blotches. Cauda yellow, short, globular, with five long bristle-like and several smaller hairs. Anal plate yellow, deeply bilobed, and provided with a few long, stout hairs supplemented with several shorter ones.

Immature forms are pale yellow to orange, with from six to eight rows of very prominent dusky tubercles, each bearing stiff, long, capitate hairs.

Described from over two hundred specimens collected at various places in Wisconsin, Illinois, Pennsylvania, Minnesota, New York, Georgia, South Carolina, Mississippi and other states.

Host plants. Black walnut (*Juglans nigra*), butternut (*Juglans cinerea*), shagbark hickory (*Carya ovata*), bitternut (*Carya cordiformis*), and pecan (*Carya illinoensis*). Names of the trees given after Gray.

Habit of feeding. This species feeds singly or in small scattered colonies, usually near the mid-rib or lateral veins on lower side of the leaves.

Distribution. It is evidently distributed throughout the eastern half of the United States and Southern Canada, wherever host plants are available. It has not been collected in the area of the Great Plains and in the Western states.

Type locality. It is advisable to limit the type locality to two states, namely, Illinois and Wisconsin.

Cotypes in the collections of the U. S. National Museum, Illinois State Natural History Survey, and in the private collection of A. A. Granovsky, are listed in the following tabulation:

Date	Locality	Collector	Hosts	Number of slides	Alate viviparous females	Nymphs	Sexes
July 24, 1925	Egg Harbor, Wis...	A. A. G.	Butternut...	2	3	1	.....
Aug. 12, 1925	Egg Harbor, Wis...	A. A. G.	Butternut...	2	2	3	.....
Aug. 17, 1925	Sun Prairie, Wis...	A. A. G.	Hickory.....	3	3	6	.....
July 8, 1927	Viroqua, Wis.....	A. A. G.	Black walnut	2	5	1	.....
Aug. 7, 1927	Egg Harbor, Wis...	A. A. G.	Black walnut	2	15	.....	.....
Aug. 9, 1927	Green Bay, Wis...	A. A. G.	hickory.....	3	7	13	.....
Aug. 23, 1927	Egg Harbor, Wis...	A. A. G.	Butternut...	5	10	.....	.....
Sept. 2, 1927	Green Bay, Wis...	A. A. G.	Hickory.....	6	4	18	4 ♂ 14 ♀
June 21, 1928	Havana, Ill.....	F. & H.	Hickory.....	3	4	2	.....
June 19, 1929	Grayville, Ill.....	F. & H.	Walnut.....	5	12	1	.....
June 20, 1929	Elizabethtown, Ill.	F. & H.	Hickory.....	3	6	.....	.....
June 20, 1929	Elizabethtown, Ill.	F. & H.	Black walnut	1	4	.....	.....
June 22, 1929	Cairo, Ill.....	F. & H.	Hickory.....	2	4	.....	.....

In addition to the cotypic material listed above we have the following Illinois records: Kankakee (July 29), Metropolis (June 1), Mt. Carroll (June 25), Urbana (July 10), 1928; and Columbia (Sept. 11), 1929. All taken on *Carya illinoensis*, *Carya ovata*, or *Carya* sp.

GENUS MYZOCALLIS PASSERINI

(SUBGENERA MYZOCALLIS PASSERINI AND THERIOAPHIS WALKER)

Key to the Species of the Genus *Myzocallis*

1. Wings between veins conspicuously mottled with brownish or blackish patches (Fig. 61); markings not restricted to bordering of veins or to costal area.....2
- Wings between veins not conspicuously mottled (Fig. 63); dark markings restricted either to the apices and bordering of veins or to costal area.....4
2. Cornicles and area around their base dark-colored.....
- Cornicles and area around their base not dark but light.....3
3. Species found on milkweed (*Asclepias*).....*asclepiadis* (Monell) p. 256
- Species found on oak (*Quercus*).....*alhambra* Davidson p. 255
4. Cornicles almost or at least with apical portion dark-colored.....5
- Cornicles entirely light-colored.....7
5. Dorsum of abdomen with numerous dark patches or spots; third antennal segment with about eight secondary sensoria.....
- Dorsum of abdomen without dark patches or spots; third antennal segment usually with less than six secondary sensoria.....6
6. Basal third of third antennal segment with two to four secondary sensoria.....
- Basal portion of third antennal segment without secondary sensoria, sensoria numbering from three to eight and located upon swollen middle area of segment (Fig. 249).....
- Basal portion of third antennal segment dark-colored and with more or less oval or transverse oval sensoria.....
- Basal portion of third antennal segment light-colored and with round sensoria.....8

8. Fore wings with tips of all or almost all veins ending in fuscous areas *punctata* (Monell) p. 259
- Fore wings with tips of few or no veins ending in fuscous areas.....9
9. Fore wings immaculate except for small dark spot in stigmal area; forms small; on hazel (*Corylus*).....*coryli* (Goeze) p. 257
- Fore wings not entirely immaculate, usually a distinct dark band extending along costal margin to tip of wing (Fig. 63); on oak (*Quercus*)10
10. Femora of fore legs mostly dark.....*bella* (Walsh) p. 257
- Femora of fore legs mostly pale.....*walshii* (Monell) p. 259

MYZOCALLIS ALHAMBRA DAVIDSON

FIG. 334

Myzocallis alhambra Davidson, Canadian Entomologist, Vol. LII, No. 6, August, 1920, p. 176.

This species has been determined for us by Dr. Granovsky and is here recorded from Illinois for the first time. It is so closely related to *M. asclepiadis* (Monell) that we have been unable to separate it from the latter except upon the basis of host plants. Davidson described this species from California. Our material has been collected on *Quercus macrocarpa*, *Quercus alba*, and *Quercus bicolor*. Since the sexual forms have not been described, brief descriptions of them are presented here.

Data associated with our specimens are as follows: Carbondale (June 4), Catlin (Sept. 27), Havana (June 20), 1928; El Paso (July 5), Urbana (Oct. 11, 15), 1929; Urbana (Oct. 20, 24), 1930. Sexual forms were taken at Urbana on various dates in October, 1929 and 1930. A mating pair was taken on October 24, 1930.

ALATE MALE

Size and general color.—Length from vertex to tip of anal plate, 1.35. Width of head across eyes, .45. Head and thorax dark brown, thorax with lighter areas. Dorsum and venter of abdomen with segmentally arranged, wide, oblong dark brown areas occupying most of the two aspects; lateral margins of abdomen with quadrate dark spots; area between these spots yellowish green, sometimes interspersed with small round brownish areas; gonapophyses brown. Antennal flagellum brown, bases of segments lighter. Legs and wings as in alate viviparous female. Cornicles dusky, but with a clear area surrounding the base.

Structure.—Average comparative antennal lengths as follows: III—.51, IV—.36, V—.30, VI—.14 plus .20. Secondary sensoria present on all segments of flagellum, numbering as follows: III—32, IV—21, V—7, VI—3. Otherwise as in alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of abdomen, 2.04. Width of head across eyes, .43. Venter of body and general ground color of other portions yellow. Antennae yellowish with apical portions of flagellar segments and all of sixth except base, dusky. Dorsum of body with dark brown markings and clothed with capitate setae arising from distinct tubercles. Pattern of color markings and setae as in Fig. 334. Legs mostly concolorous with body, but with tarsi and extreme apices of tibiae blackish.

Comparative antennal lengths as follows: III—.43, IV—.26, V—.21, VI—.11 plus .17. Secondary sensoria absent. Hind tibiae swollen, with about 60 sensoria. Cornicle and cauda as in alate viviparous female.

Allotype.—Alate male; Slide No. 9654, Urbana, Illinois, October 24, 1930, on *Quercus macrocarpa*, (Frison and Ross). On slide with males. *Morphotype.*—Apterous oviparous female; Slide No. 9350, Urbana, Illinois, October 11, 1929, on *Quercus macrocarpa*, (Frison and Ross).

MYZOCALLIS ALNI (DeGeer)

Aphis alni DeGeer, Memoirs pour servir à l'histoire des Insectes, Tome 3, 1773, p. 47.

This species was first reported from the United States by Davis (1910d) from specimens collected in parks at Chicago, Illinois, on the undersides of alder leaves (*Alnus* sp.). He stated that it was rather common at time of collection, October 1, 4, and 20, 1909. It has not been reported from this state since then. Davis described the alate viviparous females and sexual forms. All forms have been redescribed in detail and figured by Granovsky (1928b). Davis (1919) referred his determination of this species in 1910 to *alnifoliae* (Fitch), but Granovsky has shown that the original determination of Davis was correct. According to Granovsky it is known in North America only from Illinois, Oregon, and British Columbia. It is a common species in Europe (Theobald, 1927).

MYZOCALLIS ALNIFOLIAE (FITCH)

FIG. 249

Lachnus alnifoliae Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 67.

This species is here recorded for the first time from Illinois, since the record of Davis (1919) refers to *M. alni* (DeGeer). It was found to be exceedingly abundant on the undersides of the leaves of alder (*Alnus* sp.) in the Ozarkian region of southern Illinois. Granovsky (1928b) has given detailed descriptions and illustrations of all forms, as well as a summary of its present known distribution.

Data associated with our specimens are as follows: Herod (June 21) 1929 and (April 16) 1930.

MYZOCALLIS ASCLEPIADIS (MONELL)

FIG. 311

Callipterus asclepiadis Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 29.

Gillette (1910) was the first to report this species from Illinois, and later Davis (1910d) reported it as common throughout the state. As already mentioned elsewhere, this species is closely related to *Myzocallis alhambra* Davidson, and we have been able to separate the two only on the basis of host plants; *alhambra* occurring on *Quercus* and *asclepiadis* on *Asclepias*. Dr. Granovsky writes us that the two are distinct. It is very common in all parts of Illinois and feeds on the undersides of the leaves. A description of the previously undescribed oviparous female is given here.

Data associated with our specimens are as follows: Champaign (July 27), Danville (July 15), Havana (June 21), Kankakee (July 15), Oakwood (Sept. 17), St. Joseph (Aug. 5), Urbana (July 23), 1928; Beach (Aug. 29).

Cairo (June 22), Edwardsville (Sept. 11), Eldorado (June 19), Galena (July 10), Grayville (June 19), Jerseyville (June 25), Kansas (June 17), Richmond (July 12), Rock Island (July 7), Seymour (Oct. 16), Starved Rock State Park (July 5, 6), 1929; Cerro Gordo (Oct. 15), 1930. Oviparous females have been taken at Seymour (Oct. 16) and at Urbana (Oct. 14), 1929.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of body, 1.97. Width of head across eyes, .39. Body coloring as in oviparous female of *M. alhambra* (Fig. 334) with very similar markings and setal distribution. Average comparative antennal lengths as follows: III— .34, IV— .21, V— .21, VI— .10 plus .20. Secondary sensoria absent. Very similar to the oviparous female of *M. alhambra* and perhaps inseparable from it.

Morphotype.—Apterous oviparous female; Slide No. 8978, Urbana, Illinois, October 14, 1929, on milkweed (*Asclepias* sp.), by T. H. Frison. On slide with oviparous female.

MYZOCALLIS BELLA (WALSH)

FIG. 63

Aphis bella Walsh, Proceedings of the Entomological Society of Philadelphia, December, 1862, p. 299.

This species, originally described from near Rock Island, Illinois, by Walsh, was reported as being very common in the state by Davis (1910d). It may be collected on the undersides of the leaves of black oak, where it is often associated with the somewhat similarly colored, but smaller, species *Myzocallis walshii* (Monell). The latter has often been considered a synonym of *M. bella* (Walsh). Our determination of this species has been verified by Dr. Granovsky.

Data associated with our specimens, collected on *Quercus velutina* and *Quercus* sp., are as follows: Decatur (Sept. 18), Oregon (June 28), 1928; Decatur (Sept. 20, Oct. 12), Starved Rock State Park (Aug. 14), 1929; Starved Rock State Park (May 13), 1930. It is very likely that the sexual forms of this species are represented in a collection from Decatur (Oct. 12), but due to lack of mating pairs and mixing with material of *M. walshii* (Monell) they have not been definitely segregated and therefore are not described or recorded as such.

MYZOCALLIS CORYLI (GOEZE)

Aphis coryli Goeze, Entomologische Beyträge zu des Ritter Linné zwölften ausgabe des Natursystems, Theil II, Leipsig, bey Weidmanns Erben und Reich, 1778, p. 311.

This species was first reported from the vicinity of Chicago, Illinois, by Davis (1910d), who published descriptions and illustrations of the sexual forms and alate viviparous female. Its small size, pale color, and more or less solitary habit make this species rather difficult to collect. It frequents the under surface of leaves of hazelnut (*Corylus* sp.) and is known from Europe as well as America (Theobald, 1927).

Data associated with our specimens are as follows: Antioch (June 15), Catlin (Sept. 27), Galena (June 25, 27), Kankakee (July 15), Oregon (June 28), Urbana (July 10), 1928; Beach (Aug. 29), 1929.

MYZOCALLIS DISCOLOR (MONELL)

FIGS. 61, 168, 178

Callipterus discolor Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 30.

This species was first reported from Illinois by Davis (1910d), who stated it was common in Illinois. It is a dark-colored aphid with brown or blackish spotted wings and occurs as solitary specimens on the under surface of the leaves of oak and hickory. The sexual forms have been described by Weed (1888) and by Knowlton (1929b). Dr. Granovsky has checked our determination of this species.

Data associated with our specimens are as follows: Mt. Carmel (May 27, 28), 1884; Carbondale (June 4), Danville (Sept. 18), Decatur (Oct. 23), Herod (May 29), Mt. Carmel (May 26), Oakwood (Nov. 4), 1928; Cairo (June 21), Starved Rock State Park (Aug. 14), Urbana (Oct. 11), 1929; Starved Rock State Park (May 13), 1930. We have taken the sexual forms at Quincy (Nov. 6) and Urbana (Oct. 20), 1930.

MYZOCALLIS ONONIDIS (KALTENBACH)

FIG. 32

Aphis ononidis Kaltenbach, Entomologische Zeitung, Herausgegeben von dem entomologischen Vereine zu Stettin, Vol. VII, 1846, p. 173.

Most remarks and descriptions in literature relating to the yellow clover aphid (Fig. 32) have been recorded under the name of *Callip-*

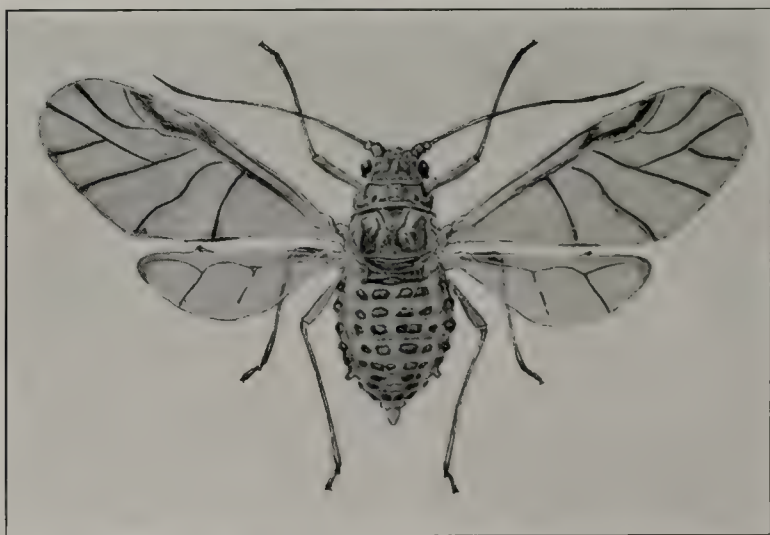


Fig. 32. Alate viviparous female of *Myzocallis ononidis* (Kaltenbach). (After Folsom: Ill. Ent. Rep. 25.)

terus trifolii Monell which is now considered to be a synonym of *M. ononidis* (Kaltenbach). This species was first recorded from Illinois

by Davis (1908c) as a "common species on clover, but of little economic significance." The accounts by Folsom (1909) and Davis (1908c, 1914b) give a very complete picture of the biology, characteristics, and structural details of all forms of this species. All writers seem to agree, and this also is our own opinion, that although the yellow clover aphid is common in clover fields every year, it does not rank with *Macrosiphum pisi* (Kaltenbach) as a serious clover pest. It is found in Eurasia and Africa as well as North America.

Data associated with our specimens, all collected on *Trifolium pratense* and *T. procumbens*, are as follows: Mascoutah (July 17), 1906; Carbondale (June 4), Herod (Oct. 12), Marshall (May 28), St. Anne (July 15), 1928; Edwardsville (Aug. 11), Elizabethtown (June 20), Farmer City (July 5), Homer (June 17), Olney (June 18), Orleans (April 15, June 15), 1929.

MYZOCALLIS PUNCTATA (MONELL)

FIG. 71

Callipterus punctata Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 30.

Myzocallis punctatus (Monell) was reported by Davis (1910d) as "not uncommon in Illinois." Very little is given in literature regarding this species, and the sexual forms have apparently not been described. Our determination of this species has been checked by Dr. Granovsky.

Data associated with our specimens, all collected on various species of *Quercus* and *Asclepias*, are as follows: Antioch (June 15), Havana (June 21), Herod (May 29), Kankakee (June 29), Mt. Carmel (May 26), Shawneetown (May 27), Urbana (May 28, 31, June 6), 1928; Bluff Springs (May 2), 1929.

MYZOCALLIS TILIAE (LINNAEUS)

Aphis tiliae Linnaeus, Systema Naturae, Editio Decima, 1758, p. 452.

This species was first reported in Illinois from Chicago and vicinity by Davis (1909b) under the name of *Callipterus tiliae*. It lives on the undersides of the leaves of basswood (*Tilia americana*). It is easily determined by its clouded wings. It is another one of the species of this supertribe which are widely distributed in North America and Europe. All forms have been described and figured in detail by Davis.

Data associated with our alate and apterous viviparous specimens are as follows: Antioch (June 16), Starved Rock State Park (June 13), Urbana (July 6, 7, Aug. 6, 11, Sept. 26), 1928; Chicago (July 13), Urbana (Oct. 16), Waukegan (July 13), 1929. Sexual forms were taken at Urbana on Oct. 16, 1929.

MYZOCALLIS WALSHII (MONELL)

FIG. 333

Callipterus walshii Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 29.

This species has not been previously recorded from Illinois. Our collections indicate that it is quite widely distributed in the state. We

are considering it a distinct species from *M. bella* (Walsh), from which it differs in having much lighter-colored legs, particularly the prothoracic legs, and lighter-colored wings and lateral stripes. Our determinations of certain of our slides of this species have been checked by Dr. Granovsky. Specimens have been collected on the undersides of leaves of various oaks and hickories (*Quercus alba*, *Q. velutina*, *Q. imbricaria*, *Quercus* sp., and *Carya* sp.).

Data associated with our specimens are as follows: Danville (Sept. 18), Golconda (Oct. 13), Havana (June 20, 21), Marshall (May 25), Mt. Carmel (May 26, 28), Oregon (June 28), Shawneetown (May 27), Urbana (June 6, July 10, 26, Aug. 23, 25, Sept. 26), 1928; Beach (July 13), Cairo (June 22), Decatur (Oct. 12), Metropolis (Sept. 28), Starved Rock State Park (July 6), Urbana (Oct. 14), 1929; Urbana (Oct. 14), 1930. Sexual forms and mating pairs have been taken on Oct. 14, 1929, and 1930, at Urbana.

We have a series of slides collected on June 1, 1928, at Metropolis, Illinois, which may represent spring forms of this species or *M. punctata* Monell, or again may represent a new species. We have preferred to consider them for the present as undetermined.

Descriptions of the undescribed sexual forms are presented here:

ALATE MALE

Size and general color.—Length from vertex to tip of anal plate, 1.37. Width of head across eyes, .40. Head and thorax dark brown except the metathorax and a longitudinal dorsal area on each side of meson of prothorax, which are luteous, and the scutellum, which is conspicuously brownish black; abdomen pale greenish yellow, with the gonapophyses brown, with from two to several pale-brown lateral tubercles, and with seven segmentally arranged, oblong, blackish-brown areas on the dorsum forming a mesal band running the length of the abdomen. Antennae grayish brown, with basal half of third segment and extreme bases of fourth and fifth segments paler. Legs as in alate viviparous female, but with the femora infuscate with grayish brown. Wings as in alate viviparous female.

Structure.—Average comparative antennal lengths as follows: III— .47, IV— .31, V— .29, VI— .15 plus .28. Secondary sensoria present on all segments of flagellum, averaging in number as follows: III— 26, IV— 13, V— 10, VI— 4. Abdomen with small lateral tubercles as mentioned in color description. Dark patches of abdomen bearing one or two lateral setae. Remaining structure, except gonapophyses, as in alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of abdomen, 1.86. Width of head across eyes, .38. Venter of entire body and ground color of dorsum greenish yellow. Antennae greenish white with the apical portion of the third, fourth and fifth segments and sixth except base, blackish. Dorsum of body with brownish black areas, these areas bearing tubercles upon each of which is a capitate seta. Arrangement of color pattern and setae as in Fig. 333. Cornicles dusky. Legs mostly concolorous with body, but with tarsi and extreme apices of tibiae blackish.

Average comparative antennal lengths as follows: III— .34, IV— .22, V— .22, VI— .16 plus .29. Secondary sensoria absent on antennae. Hind tibiae swollen, with about 70 sensoria. Cornicle and cauda as in alate viviparous female.

Allotype.—Alate male; Slide No. 9699, Urbana, Illinois, October 14, 1930, on *Quercus alba*, (T. H. Frison). On slide with other males. *Morphotype.*—Apterous oviparous female; Slide No. 9703, same data as allotype. On slide with oviparous female.

GENUS NEOSYMYDOBIUS BAKER

Key to the Species of the Genus Neosymydobius

1. Sixth antennal segment with the terminal filament shorter than the base (Fig. 245).....*albasiphus* (Davis) p. 261
- Sixth antennal segment with the terminal filament as long or longer than the base (Fig. 247).....2
2. Secondary sensoria of third antennal segment extending from near base to about two-thirds the length of segment (Fig. 254).....*annulatus* (Koch) p. 262
- Secondary sensoria of third antennal segment extending from near base almost to apex of segment (Fig. 255).....3
3. Secondary sensoria on third antennal segment averaging about nine; head and thorax brown, abdomen dorsally essentially lemon yellow; on oak.....*memoralis* n. sp. p. 262
- Secondary sensoria on third antennal segment averaging over twenty; color essentially brown; on birch.*americanus* (Baker) p. 261

NEOSYMYDOBIUS ALBASIPHUS (DAVIS)

FIG. 245

Symydobius albasiphus Davis, Canadian Entomologist, Vol. XLVI, No. 7, July, 1914, p. 226.

Davis described this species from specimens among others collected at Elgin, Illinois. Since then it has not been reported in literature. In Illinois we find that this species has no preference between the upper and lower surfaces of the leaves of certain oaks, and that it is usually, if not always, attended by ants. All forms of this plant louse were described and illustrated by Davis. The groups of sensoria-like structures on the lateral portions of the thorax and abdomen have not been mentioned in the descriptions. Our determination of this species has been verified by Dr. Granovsky.

Data associated with our specimens, all collected on *Quercus macrocarpa* or *Quercus stellata*, are as follows: Catlin (Sept. 27, Oct. 6), Cave-in-Rock (Oct. 12), Elizabethtown (May 29, 31, June 31), 1928; Elizabethtown (June 20), 1929. Sexual forms have been collected at Catlin and Cave-in-Rock on dates already mentioned.

NEOSYMYDOBIUS AMERICANUS (BAKER)

Symydobius americanus Baker, Canadian Entomologist, Vol. L, No. 9, September, 1918, p. 319.

This species has not previously been reported from Illinois. It was collected only once, in extreme northwestern Illinois, where the white, or canoe, birch (*Betula alba* var. *papyrifera*) is abundant and native. The specimens were found feeding on the young growth near base of trees.

All forms except the male have been described by Baker in the original description. According to this same author, the records of Patch (1910b) of *S. oblongus* Heyden from Maine refer to this species.

Our material consists only of apterous specimens collected at Galena, July 10, 1929.

NEOSYMYDOBIUS ANNULATUS (Koch)

FIG. 254

Chaitophorus annulatus Koch, Die Pflanzenläuse, Aphiden, Nürnberg, Heft I, 1854, p. 7.

This species, widely distributed in North America and Europe, has not previously been reported from Illinois. We have found it quite generally distributed in the state on the undersides of the leaves of cut-leaf birch (*Betula pendula*). Generically there is so little difference between this species, formerly placed in an assortment of genera, and species already placed in the genus *Ncosymydobius* that we have placed it in the latter genus. The fact that apterous viviparous forms are common throughout the year indicates that it does not belong to the genus *Calaphis* in a narrow sense as most recently placed. Van der Goot (1915) and Davidson (1917a) have described the sexual forms as well as viviparous forms.

Data associated with our viviparous specimens are as follows: Oregon (June 28), Quincy (June 1), 1928; Carlinville (Sept. 12), Champaign (Oct. 7, 9), Decatur (Oct. 3, 7), Galena (July 10), 1929. Sexual forms have been taken at Decatur and Champaign in company with viviparous forms on dates already given. A mating pair was taken at Champaign on October 9, 1929.

NEOSYMYDOBIUS MEMORIALIS new species

FIGS. 81, 150, 211, 247, 255

ALATE VIVIPAROUS FEMALE.

Size and general color.—Average length from vertex to tip of anal plate, 1.33. Head and thorax essentially chestnut-brown with darker markings; some specimens have the prothorax and head slightly lighter in color than the remaining thoracic segments. Abdomen lemon yellow on dorsum and posterior regions, with seven pairs of lateral dusky patches on the sides; cornicles arising from lateral patches but slightly lighter in color than the area around their base; anal plate concolorous with abdomen, but the cauda is a shade less yellow than the abdomen and shows some indications of being dusky, particularly along its outer margin. The first two antennal segments are concolorous with the head, the third segment is lighter in color than first and second segments except that apical one-fifth again becomes concolorous with these segments; fourth and fifth segments whitish except for apical brownish bands equal to about one-third the length of the segments; the base of the sixth segment is approximately half white and half brown, whereas the terminal process gradually shades from almost white to darker towards the apex and is never more than a dark dusky color. Femora of pro- and mesothoracic legs usually considerably lighter in color than the metathoracic femora, being yellowish-brown, with the dorsal regions somewhat darker; metathoracic femora brown except for extreme bases, which are yellowish; tibiae of all legs yellowish, usually slightly dusky at base and before apex; tarsi light brown. Stigma of fore wings light fuscous; veins brownish, anal and cubital veins darkest, all veins bordered with a light fuscous suffusion; surface of wings covered with brownish scale-like structures. Beak yellowish except extreme tip, which is brownish.

Head and appendages.—Average width of head across eyes, .40. Antennal segments with comparative lengths as follows: III— .31 to .43, average .36; IV— .20 to .26, average .23; V— .14 to .23, average .20; VI— .10 to .14; average .12 plus .16 to .21, average .20. Secondary sensoria (Fig. 255) limited to third antennal segment; varying in number from eight to ten, nine being the more common number; arranged in a straight row the length

of segment and unusually large. The beak extends to the coxae of the mesothoracic pair of legs.

Thorax and appendages.—The prothorax is quite prominent and extended laterally; upon this lateral extended area, particularly the posterior half, are grouped from six to eight sensoria-like structures. The fore wing with an accessory radial thickening (Fig. 55) and with media twice-forked; the second fork of the media is not always constant in position, but it is usually midway between the first fork of the media and the margin of the wing; an interesting feature of the venation of the wings is that none of the veins reach the margin of the wing. The tibiae of all legs are quite hairy, the longest hairs exceeding the width of the segment; hind tarsi are about equal in length to the base of the sixth antennal segment.

Abdomen.—The lateral dusky patches on the margins of the abdomen, except the patch surrounding the cornicles, contain sensoria-like structures similar to those found on the prothorax, they are very difficult to locate and count, but appear to number three or four to a patch. The cornicles (Fig. 150) are short and about as long as the anal plate, with sides slightly incurved and the valve considerably sunken. The cauda (Fig. 211) is distinctly bilobed and covered with long hairs.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.58. Head pale yellowish, thorax light dusky brown except for a few pale irregular patches, abdomen yellowish and without lateral markings. First antennal segment essentially concolorous with the head, except for a brownish tinge on the anterior margin of the segment; second segment whitish; third, fourth, and fifth segments whitish except for narrow dusky brownish bands at their apical ends which increase in intensity and length respectively; sixth segment whitish at base, then with a dark brownish area extending from about the middle of the basal portion of the segment to just beyond the primary sensorium; this band, in turn, is followed by a light area, which is followed by a dusky terminal area. The cornicles, cauda, and anal plate are concolorous with the abdomen. Legs mainly whitish-yellow, each with a dusky-brownish spot on the dorsum of the apical region of the femora (darkest on the femora of the metathoracic pair of legs); tarsi with apical halves dusky. The beak concolorous with body except extreme tip, which is dusky.

Head and appendages.—Average width of head across eyes, .40. Antennal segments with comparative lengths as follows: III— .39 to .44, average .41; IV— .24 to .26, average .25; V— .17 to .23, average .20; VI— .10 to .14, average .13 plus .13 to .21, average .17. Secondary sensoria few or lacking; when present, only on third antennal segment; distribution irregular (one specimen has four secondary sensoria on one antenna and one on the other); situated near the apex or middle area of the segment. The beak reaches between coxae of the meso- and metathoracic legs.

Thorax and appendages.—The prothorax with sensoria-like structures on posterio-lateral margins similar to those of the alate viviparous female. The tibiae have long decumbent hairs; the tarsi are slightly over half as long as the fifth segment of the antennae.

Abdomen.—The lateral margins of the abdomen have segmentally arranged sensoria-like structures similar to the alate viviparous females but the light color of the abdomen makes their differentiation exceeding difficult. The abdomen of this form is otherwise similar to the abdomen of the alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.28. Head mainly yellowish with a tinge of fuscous, thorax mainly dusky brown; abdomen yellowish on dorsum and with fuscous lateral patches. First and second antennal segments essentially concolorous with head, remaining segments as in apterous viviparous female. Femora light dusky yellow, dorsal regions darkest, posterior femora considerably darker than

anterior pair; tibiae of pro- and mesothorax uniformly light dusky, posterior tibiae darker than tibiae of anterior pairs of legs; all tarsi light dusky.

Head and appendages.—Average width of head across eyes, .41. Antennal segments with comparative lengths as follows: III— .36 to .37, average .36; IV— .21 to .26, average .23; V— .19 to .20, average .19; VI— .14 to .14, average .14 plus .20 to .21, average .20. No secondary sensoria on antennae. The beak extends to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Prothorax similar to prothorax of apterous viviparous female. Hind tibiae swollen and thickly studded with sensoria, which extend from base to about two-thirds length of the segment; as many as 60 sensoria have been counted on a tibia, but this is scarcely more than an estimate because they are very difficult to count accurately.

Abdomen.—Lateral portions of abdomen similar to alate viviparous female except that there appear to be fewer sensoria-like structures. Cornicles similar to cornicles of alate viviparous female. Cauda not discernible or distinctive characters not evident. Ovipositor elongate and typical for genus.

Holotype.—Alate viviparous female; Elizabethtown, Illinois, May 31, 1928, on *Quercus stellata*, (Frison and Hottes). Slide No. 10103. *Morphotype.*—Apterous viviparous female; Elizabethtown, Illinois, June 20, 1929, on *Quercus stellata*, (Frison and Hottes). On slide with two nymphs. Slide No. 10104. *Morphotype.*—Apterous oviparous female; Elizabethtown, Illinois, October 12, 1928, on *Quercus stellata*, (Frison and Hottes). On slide with apterous viviparous and oviparous female and nymphs. Slide No. 10105. *Paratypes.*—Eighteen slides of alate and apterous viviparous females, oviparous females, pupae and nymphs; all collected at Elizabethtown, Illinois, on *Quercus stellata*, by T. H. Frison and F. C. Hottes, on May 29-31 and October 12, 1928, and June 20, 1929. Slides Nos. 10106-10120 and other unnumbered.

This species is probably most closely allied to *Ncosymydobius albasiphus* (Davis), from which it may be separated at once by its color and by the fact that the terminal process of the sixth antennal segment is much longer than its base. This species occurs in nature on the same leaves with *Ncosymydobius albasiphus* (Davis) and is found on both the dorsal and ventral surfaces of the leaf. It seems to prefer the regions close to the mid-rib and principle veins. Specimens were sent to Dr. Granovsky for examination, who confirmed our belief that it was undescribed.

Since this species was first collected on Memorial Day, in 1928, the specific name of *memoralis* has been assigned to it.

GENUS PHYLLAPHIS KOCH

PHYLLAPHIS FAGI (LINNAEUS)

FIGS. 13, 159

Aphis fagi Linnaeus, Systema Naturae, Addition 12, 1767, p. 735.

This widely distributed species has not previously been reported from Illinois. It occurs in flocculent masses on the undersides of the leaves of beach (*Fagus grandifolia*), which occurs as a native tree in extreme southern Illinois and in a few other counties in the state. Thus far we have taken this species only in southern Illinois in woods where the beach was abundant and never on specimen trees in other parts of the state. Future collecting may reveal its presence in Vermilion County, Illinois, where some small stands of native beach still exist.

Good accounts of the habits of this plant louse and descriptions of all the forms are given by Swain (1919) and Theobald (1927). The latter author states it often does a great deal of harm to beach trees and hedges in Europe.

Data associated with our apterous viviparous specimens are as follows: Marshall (May 25), 1928; Jonesboro (June 23), Mounds (June 21), 1929.

GENUS SALTUSAPHIS THEOBALD

Key to the Species of the Genus *Saltusaphis*

1. Alate and apterous viviparous females with posterior margin of abdomen distinctly bilobed (Fig. 215).....*elongata* Baker p. 265
- Alate and apterous viviparous females with posterior margin of abdomen not distinctly bilobed, almost truncate (Fig. 219)....
.....*wanica* n. sp. p. 266

SALTUSAPHIS ELONGATA BAKER

FIGS. 215, 233, 321

Saltusaphis elongatus Baker, Canadian Entomologist, Vol. XLIX, No. 1, January, 1917, p. 4.

This elongate and yellowish species has not previously been reported from Illinois; in fact we are not aware that it has been reported from other than the typic locality of New Jersey and Madison, Wisconsin. At Seymour, Illinois, in a low prairie habitat, this species is very common, and it has been under observation from June until the last of October. It is most easily taken by sweeping species of *Carex*. Evidently no alate viviparous females are produced and the sexual forms are likewise apterous. Our determination of *Saltusaphis elongatus* has been verified by Dr. Granovsky. Since we know of no description of the male of this species, the description of this form is presented.

Data associated with our apterous viviparous females, all taken on *Carex* sp., are as follows: Beach (Aug. 30), Mineral (July 8), Seymour (June 13, 26, July 20, Aug. 6, Oct. 7, 16, 30), Silvis (July 9), Villa Ridge (Aug. 30), 1929. Sexual forms were first observed at Seymour on Oct. 16, 1929, and were very numerous on Oct. 30, 1929, when mating pairs were collected.

APTEROUS MALE

Size and general color.—Average length from vertex to tip of cauda, 1.90. Body pale yellow, with anterior portion of head, extreme lateral margin of abdomen, and cornicles pale yellowish brown; dorsum of thorax and abdomen with small brownish spots between segments, some spots confluent. Genitalia dark brown. Femora pale yellow, tibiae and tarsi slightly dusky. Antennae with first two segments and base of third concolorous with vertex, remainder of flagellum uniformly dark brown except that terminal filament is sometimes as light as the base. Beak yellowish except for extreme tip which is brownish.

Structure.—Average width of head across eyes, .40. Comparative lengths of antennal segments as follows: III— .79 to .97, average .87; IV— .49 to .51, average .50; V— .43 to .47, average .46; VI— .20 to .21, average .21 plus .36 to .39, average .37. Secondary sensoria (Fig. 233) located on the third,

fourth, and fifth antennal segments, all arranged in a very regular row and very minute, average distribution as follows: III— 20, IV— 10, V— 12, greatest variation from average being 2. All segments very finely imbricated. Posterior extremity of body much like that of apterous oviparous female except that the posterior notch is less deep.

Allotype.—Apterous male; Slide No. 8244, Seymour, Illinois, on *Carex* sp., October 30, 1929, (T. H. Frison). On slide with oviparous female; mating pair.

SALTUSAPHIS WANICA new species

FIGS. 219, 237, 242

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 2.19. General color of body light yellowish with dusky brown lateral patches. Head light yellowish on dorsum with light dusky brown patches laterally and anteriorly. Prothorax with mesal third of dorsum yellowish and with lateral portions light dusky brown; mesothorax with dorsal lobes light brown and lateral portions yellowish; metathorax yellowish with small dusky patches at sides. Abdomen light yellowish with lateral spots on first seven segments; cornicles, cauda, anal plate, and an irregular oblong patch in center of dorsum, a dusky brown; posterior to dorsal patch are five or six small dusky spots; lateral to large spot on dorsum, and following this, are several groups of from 2 to 3 minute dusky spots. Cornicles situated in, and concolorous with, the lateral dusky spots. First and second antennal segments yellowish dusky; third segment, with the exception of the extreme base, uniform brown; basal half of fourth and fifth segments yellowish, apical portions brownish; sixth antennal segment with the terminal process somewhat lighter than the base, otherwise concolorous with apical portion of fifth. Pro- and meso-thoracic femora yellowish with brownish markings towards apex; meta-thoracic femora yellowish at the base and extreme tip, otherwise brownish. All tibiae yellowish except for extreme tips, which are dusky; tarsi dusky. Stigma of fore wings light dusky brown with a brownish suffusion posteriorly; veins light brown, ending in brownish suffusion, posterior portion of wing in vicinity of anal vein dusky brown. Beak yellowish with extreme tip light brown.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with the following comparative lengths: III— .57; IV— .40; V— .33; VI— .20 plus .21. Secondary sensoria (Fig. 237) confined to third antennal segment, arranged in a straight row, varying greatly in size and numbering 11 and 12. Marginal sensoria on sixth antennal segment probably lacking. All segments very finely imbricated and sparsely clothed with exceedingly fine hairs. Head with vertex rounded, with two rather large spine-like hairs on the front and with numerous, scattered, finer hairs. Beak very short, reaching only to posterior margin of prothorax. Ocelli well developed, lateral ocelli close to eyes.

Thorax and appendages.—Prothorax with postero-lateral corners turned outward, the sides somewhat bell-shaped in contour, thickly set with glandular structures on the dorsum; mesal half of mesonotum also glandular. Stigma of fore wings long and narrow, second fork of media considerably closer to margin of wing than to the first fork. Hind femora with about 12 sensoria on inner surface.

Abdomen.—Cornicles mere elevated pores, typical for the genus. Posterior extremity of abdomen transverse, at most only a little indented on the meson. Cauda .10 long, distinctly knobbed; cauda and posterior extremity with a few spine-like hairs. Anal plate bilobed. Entire surface of abdomen covered with exceedingly small, delicate imbrications. Surface of thorax and abdomen very sparsely covered with mushroom-like hairs.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.31. Head, thorax, and abdomen pale yellow; thorax and abdomen oc-

casionally with exceedingly faint dusky markings along lateral margins, in rare cases abdomen with narrow, faint, somewhat broken, fuscous, transverse bands on the dorsum. Eyes reddish-brown. First and second antennal segments concolorous with head; third segment very pale yellowish except for extreme apical portion, which is dusky brown; fourth with basal half to two-thirds yellowish, remaining portion dusky brown; fifth with varying amount of the basal portion yellow, and the remaining portion dusky brown; sixth segment dusky, usually with the terminal filament lighter than base, and extreme base pale. Legs entirely pale yellowish. Beak yellowish with extreme apical portion light dusky brown.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with the following comparative lengths: .III— .44 to .59, average .49; IV— .27 to .36, average .32; V— .26 to .34, average .30; VI— .17 to .23, average .21 plus .17 to .21, average .20. Secondary sensoria absent. Marginal sensoria on sixth antennal segment probably lacking. Beak reaching just beyond prothoracic coxae. Anterior margin of head considerably arched with four long hairs near center.

Thorax.—Prothorax with posterior margin expanded, but not with postero-lateral portions produced. Mushroom hairs more abundant than on alate form.

Abdomen.—Cornicles similar in shape to those of the alate viviparous female. Posterior portion of abdomen quite variable in shape, sometimes not unlike that of alate viviparous female, at other times considerably indented and somewhat prolonged laterally. Cauda (Fig. 219) .09 in length; it and anal plate (Fig. 219) similar to those of alate viviparous female. Angular portions of abdomen posterior to cornicles, with long spine-like hairs. Abdomen finely imbricated, with short mushroom-like hairs.

Holotype.—Alate viviparous female; Mitchell, Illinois, June 25, 1929 on *Carex* sp., (Frison and Hottes). Slide No. 10626. *Morphotype.*—Apterous viviparous female; Cairo, Illinois, June 22, 1929, on *Carex* sp., (Frison and Hottes). On slide with nymphs. Slide No. 10627. *Paratypes.*—Twenty-eight slides containing pupae, apterous viviparous females, and nymphs, all collected in Illinois on *Carex* sp. by T. H. Frison and F. C. Hottes. The dates and localities are as follows: Beach (August 30), Cairo (June 22), Elizabethtown (June 20), Galena (July 10), Mitchell (June 25), Seymour (June 13, 26, July 20, Oct. 7), Wenona (July 5), Woodford (July 5), 1929. Slides Nos. 5599-5602, 5608-5611, 5629-5630, 10628-10641 and others unnumbered.

This species is closely related to *S. virginicus* Baker, but differs in having annulated antennae and the terminal filament of the sixth antennal segment subequal to the base. Specimens of this species, questionably determined as *S. virginicus*, were submitted to Dr. Granovsky for determination, and he very kindly reported after a comparison with types of *virginicus* that they were likely a new species.

SIENAHWEUM new genus

Cornicles small, cylindrical, tapering to tip, without flange. Cauda rounded at apex, showing almost no constriction. Anal plate scarcely indented. Antennae with six segments. Dorsum of abdomen without tubercles. Fore wings with media twice-forked. Differs from *Drepanaphis* in being smaller; in having differently shaped cornicles, the anal plate less indented, and the cauda not knobbed; and in lacking prominent dorsal tubercles.

Genotype, *Drepanaphis minutus* Davis, by original and present designation.

SHENAHWEUM MINUTUM (DAVIS)

FIG. 325

Drepanaphis? minutus Davis, Entomological News, Vol. XXI, No. 5, May, 1910, p. 195.

This species was described by Davis from specimens collected at Glencoe, Illinois, September 2, 1909, on *Acer saccharum*. We failed to find this species during our collecting in various parts of the state during the last three years.

GENUS STEGOPHYLLA OESTLUND

STEGOPHYLLA QUERCICOLA (BAKER)

Phyllaphis quercicola Baker, Entomological News, Vol. XXVII, No. 8, October, 1913, p. 362.

Until the appearance of Baker's paper (1916b), *querci* Fitch was the name used by American writers for at least two species belonging to widely separated genera, one of which was the species now under discussion. The first definite record of *quercicola* (Baker) from Illinois is the listing of Davis (1911a), under the name of *Phyllaphis? querci* (Fitch), of specimens collected on oaks at Aurora, Chicago, Danville, Joliet, Normal, Peoria, and Rockford, Illinois. Baker (1916b) proposed *Phyllaphis quercicola* as a new name for the form now under discussion.

Davis (1911a) has given a good account, as well as detailed descriptions of all stages, of this aphid. It lives in small scattered colonies on the upper and lower surfaces of leaves of various species of oaks and produces a rather dense flocculence. Davis states that both alate and apterous males are produced. It is interesting that all our males collected in southern Illinois (Herod and Cave-in-Rock) are winged, whereas those from central Illinois (Urbana) are all apterous.

Data associated with our specimens are as follows: Cave-in-Rock (Oct. 12), Decatur (Oct. 3), Muncie (Oct. 6), 1928; Columbia (Sept. 11), Herod (Sept. 27), Starved Rock State Park (Aug. 14), Urbana (Oct. 11), 1929; Urbana (Oct. 24), 1930. Collections made in late September and October at Cave-in-Rock, Herod, and Urbana, include the sexual forms. No winged viviparous females have been taken.

GENUS TAMALIA BAKER

TAMALIA COWENI (COCKERELL)

FIGS. 33, 83, 244

Pemphigus coweni Cockerell, Canadian Entomologist, Vol. XXXII, No. 11, November, 1905, p. 392.

The collection of this gall-making insect in Illinois is interesting in that its host, the bearberry, has a very restricted distribution in Illinois and is sometimes considered as a boreal relic. Because of the

strict fidelity of *T. coweni* (Ckll.) to the genus to which its host belongs, it is very probably confined to the sandy beach area along Lake Michigan in northeastern Illinois. This plant louse causes the leaves of bearberry to fold over and form a sort of bladder-like gall (Fig. 33) within which the aphids live well protected from some of their enemies.

Good descriptions and illustrations of all forms are given by Gillette (1909a) and Essig (1915). There has been considerable doubt concerning the generic relationships of this aphid, and it has been placed



Fig. 33. Bladder-like galls of *Tamalia coweni* (Cockerell) on the bearberry, *Arctostaphylos Uva-ursi*, caused by folding together and swelling of leaves; Beach, July 13, 1929.

in about as many different genera as there are citations to it in literature. We believe that Baker (1920) was correct in making a new genus for this species. Baker (1920) in his original description of the genus states that the media of the fore wing is once-branched, whereas this should read twice-branched. One feature in the biology of this insect is that the oviparous females are winged.

All of our material has been collected on *Arctostaphylos Uva-ursi* at Beach, Illinois; the alate and apterous viviparous females on July 13, and the oviparous females on August 29, 1929.

GENUS THRIPSAPHIS GILLETTE

Key to the Species of the Genus Thripsaphis

(Based upon apterous viviparous forms because alate forms are not common or are undescribed.)

1. Third antennal segment longer than width of head through the eyes *verrucosa* Gillette p. 271
- Third antennal segment not longer than width of head through the eyes 2
2. Third antennal segment with two or three secondary sensoria; posterior portion of body terminating in a rounded point (Fig. 218), body never with transverse grey bands.. *producta* Gillette p. 270
- Third antennal segment without secondary sensoria; last transverse segment with its posterior margin of abdomen almost straight and sides broadly rounded (Fig. 212); body always with transverse bands of grey..... *ballii* (Gillette) p. 270

THRIPSAPHIS BALLII (GILLETTE)

FIGS. 212, 324

Brachycolus ballii Gillette, Canadian Entomologist, Vol. XL, No. 2, February, 1908, p. 67.

This aphid has not previously been reported from Illinois; in fact, it has been recorded from only three states, Colorado, New Jersey, and New York. It was transferred to the genus *Saltusaphis* by Baker (1917a) and later made the genotype of *Thripsaphis* (Gillette (1917b)). The alate and apterous viviparous females have been described and figured by Gillette (1909b). Like the other species of this genus, it may be collected on various species of *Carex*, but sweeping for it is much less effective than a careful examination of the leaves.

Data associated with our alate and apterous viviparous specimens are as follows: Decatur (Sept. 29), 1928; Allerton (June 17), Decatur (June 12), Homer (June 17), Lawrenceville (June 18), Lisle (July 14), Mitchell (June 25), Seymour (June 13, Oct. 7), 1929.

THRIPSAPHIS PRODUCTA GILLETTE

FIG. 218

Thripsaphis producta Gillette, Canadian Entomologist, Vol. XLIX, 1917, p. 196.

This is the first record in literature of this species having been taken since it was described by Gillette from material collected in Colorado. It was found at only one locality in Illinois. Only the alate and apterous viviparous females have been described.

Our material consists solely of the apterous viviparous females and nymphs collected on *Carex* sp., at Danville on July 16 and 22, 1930.

THRIPSAPHIS VERRUCOSA GILLETTE

FIG. 322

Thripsaphis verrucosa Gillette, Canadian Entomologist, Vol. XLIX, 1917, p. 194.

This aphid, with the peculiar projection from the vertex, has not previously been reported in literature as having been taken outside of the typical locality of Colorado. Its host is the same as for the other species of this genus, namely, *Carex*. The oviparous female was included through error in the original description of *T. ballii* (Gill.). This mistake was later corrected by Gillette when the specific name of *verrucosa* was proposed. Since only the oviparous female has been described, a description of the apterous viviparous female is here presented.

We have taken only apterous viviparous females, at Danville on July 16 and 22, 1930.

APTEROUS VIVIPAROUS FEMALE

Length from anterior margin of vertex to tip of abdomen, 2.29. Width of head across eyes, .49. Body entirely pale yellow except the eyes and the antennae beyond and including the extreme apex of the third segment, which are black, and the extreme apex of the tarsi, which are dusky.

Average comparative antennal lengths as follows: III— .56, IV— .32, V— .29, VI— .16 plus .19. Secondary sensoria absent. Cauda, anal plate, and terminal segment of abdomen as in Fig. 322. Otherwise, except in secondary sexual characters, as in apterous oviparous female.

Morphotype.—Apterous viviparous female; Slide No. 9411, Danville, Illinois, August 22, 1930, on *Carex* sp., (Hottes and Tauber).

GENUS TUBERCULATUS MORDVILKO

Key to the Species of the Genus Tuberculatus

1. Wings with dark fuscous markings; on oaks. *punctatella* (Fitch) p. 271
- . Wings clear, without dark fuscous markings; on elm.....
..... *ulmifolii* (Monell) p. 272

TUBERCULATUS PUNCTATELLA (FITCH)

FIGS. 56, 319

Aphis punctatella Fitch, Transactions of the New York State Agricultural Society, Vol. XIV, 1854 (printed 1855), p. 869.

This species is here reported from Illinois for the first time. Because of the well-developed tubercles on the dorsum, it is here considered as belonging to the genus *Tuberculatus*. It is to be looked for on the undersides of oak and hickory leaves. Only the alate viviparous females have been described (Baker, 1917b).

Data associated with our alate specimens, all collected on *Quercus macrocarpa*, *Quercus alba*, *Quercus velutina*, *Quercus* sp., and *Carya* sp., are as follows: Danville (Sept. 18), Decatur (Oct. 23), Metropolis (June 1), Mt. Carmel (May 26), Rock Island (June 24), Shawneetown (May 27), 1928; Collinsville (Sept. 11), Mahomet (Aug. 17), Starved Rock State Park (Aug. 14, Sept. 10), Urbana (Oct. 11), 1929; Starved Rock State Park (May 13), 1930.

TUBERCULATUS ULMIFOLII (MONELL)

Callipterus ulmifolii Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 29.

Gillette (1910) first reported this species from Illinois (Chicago). Soon after this it was reported by Davis (1910d) as being abundant on elms in Illinois, and sometimes "sufficiently common to do injury, causing the foliage to drop prematurely and coating the upper surfaces of the leaves with honey dew." Our records indicate that this yellowish species, which inhabits the undersides of elm leaves, is quite generally distributed in our state. It may be collected throughout the year on this host, as it does not migrate. Descriptions of the male and oviparous female of this species, which have not previously appeared in the literature, are given here.

Data associated with our alate viviparous females and nymphs are as follows: Champaign (June 12, 18), 1886; Cave-in-Rock (Oct. 12), Danville (Sept. 18), Oakwood (Sept. 17), St. Joseph (Aug. 5), Urbana (July 26), 1928; Bloomington (July 5), Cairo (June 21), Edwardsville (Sept. 11), Elizabethtown (June 20), Galena (July 10), Grayville (June 19), Hardin (June 25), Olney (June 18), Rock Island (July 7), Starved Rock State Park (July 6), Urbana (Oct. 9), Waukegan (July 13), 1929. Sexual forms were taken at Urbana on October 9, 1929. Collected on *Ulmus americana*, *Ulmus alata*, and *Ulmus fulva*.

ALATE MALE

Average length, 1.00. General color brownish, tubercles darkest; antennae and legs yellowish, except apical portions of femora and tarsi, which are light dusky. Genitalia dark brownish-black. Stigma with a large central clear spot, margins brownish, veins brownish with more or less brownish suffusions at their origin. Average width of head across eyes, .40. Antennae with the following average comparative lengths: III— .45; IV— .24; V— .18; VI— missing. Secondary sensoria present on the third, fourth, and fifth antennal segments, always arranged in a straight row, numbering as follows: III— 13; IV— 4; V— 3. Second fork of media closer to margin of wing than to first fork.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 1.45. General color brownish; caudal region of abdomen yellowish; antennae and legs very light yellowish, except for apical portions of antennal segments which are dusky. Average width of head across eyes, .37. Average comparative lengths of antennal segments as follows: III— .30; IV— .18; V— .18; VI— .12 plus 12. Secondary sensoria absent. Hind tibiae much swollen and with numerous sensoria, which, because of the light color of the tibiae, can not be counted. Hairs on body distinctly enlarged at the tip and situated on tubercle-like bases.

Allotype.—Alate male; Slide No. 8688, Urbana, Illinois, on *Ulmus americana*, October 9, 1929. (T. H. Frison.) On slide with oviparous female and nymphs. *Morphotype*.—Apterous oviparous female; Slide No. 8687, same data as allotype. On slide with male and nymphs.

The cotypes of *Callipterus ulmicoia* Thomas, previously recorded by Davis (1913) and placed as synonymous with *T. ulmifolii* (Monell), are mounted on Slide No. 7166 and have the following data associated with them: Sauk City, Wisconsin, June, on elm, collected by Bundy.

SUPERTRIBE MACROSIPHEA

Key to Genera

1. Radial sector of fore wing deeply curved downward and either united with media to form a closed cell beneath stigma (Fig. 74) or almost uniting with media (Figs. 58, 66).....2
- Radial sector of fore wing not deeply curved downward, no closed cell beneath stigma (Fig. 62).....3
2. Hind wings normally with two oblique veins (Fig. 91), closed cell of fore wings, if present, three-sided (Fig. 58).....
- Hind wings normally with one oblique vein (Fig. 95), closed cell of fore wings always present and at least four-sided (Fig. 74)..... *Idiopterus* p. 292
3. Hind wing without oblique veins (Fig. 96)..... *Microparsus* p. 333
- Hind wing with oblique veins (Fig. 91).....4
4. All veins of fore wings conspicuously outlined with wide fuscous borders (Fig. 66)..... *Idiopterus* p. 292
- Some veins of fore wings not conspicuously outlined with fuscous (Fig. 72), a few species with cubitus and anal veins so outlined (Fig. 57).....5
5. Head with antennal tubercles prolonged into finger-like processes (Fig. 85)..... *Phorodon* p. 345
- Head with antennal tubercles not prolonged into finger-like processes (Figs. 82, 84, 86).....6
6. Head with antennal tubercles converging (Fig. 86) or projecting forward (Fig. 82); apterous viviparous females with (Fig. 82) or without (Fig. 86) conspicuous globate hairs on front of head between antennae.....7
- Head with antennal tubercles diverging (Fig. 84); apterous viviparous females without conspicuous globate hairs (Fig. 84) on front of head between antennae.....8
7. Apterous viviparous females always with conspicuous globate hairs (Fig. 320) on front of head between antennae.....
- Apterous viviparous females without conspicuous globate hairs on front of head between antennae..... *Capitophorus* p. 280
8. Cornicles bulging or swollen (Figs. 121, 126, 127), usually conspicuously so and never with sides entirely straight.....
- Cornicles essentially cylindrical or tapering (Figs. 100, 113, 115), not conspicuously swollen; sometimes, however, with apex of cornicles constricted and (in *M. ribiellum* and *M. crataegi*) cornicles slightly swollen..... *Amphorophora* p. 273
- Cornicles essentially cylindrical or tapering (Figs. 100, 113, 115), not conspicuously swollen; sometimes, however, with apex of cornicles constricted and (in *M. ribiellum* and *M. crataegi*) cornicles slightly swollen..... *Macrosiphum* p. 293

GENUS AMPHOROPHORA BUCKTON

Key to the Species of the Genus Amphorophora

1. Apex of cornicles distinctly reticulated (Fig. 126)..... *vaccinii* Mason p. 280
- Apex of cornicles not reticulated but sometimes imbricated (Figs. 121, 123).....2
2. Secondary sensoria present on third, fourth, and fifth antennal segments.....3
- Secondary sensoria always lacking on fifth segment.....5

3. Cornicles much longer than width of head through eyes; hind tibiae black or fuscous.....4
- Cornicles shorter or not longer than width of head through eyes; hind tibiae with only apex black or fuscous.....*cosmopolitana* Mason p. 274
4. Cornicles much shorter than fourth antennal segment and weakly swollen*sensoriata* Mason p. 279
- Cornicles longer than fourth antennal segment and strongly swollen*nabali* (Oestlund) p. 275
5. Secondary sensoria numerous on fourth antennal segment.....*sensoriata* Mason p. 279
- Secondary sensoria lacking on fourth antennal segment.....6
6. Cornicles scarcely more than three times as long as greatest diameter and entirely black.....*solani* Thomas p. 280
- Cornicles five or six times as long as greatest diameter and black, fuscous, or greenish brown.....7
7. Fourth and fifth antennal segments with basal portion light and apical portion fuscous or black; cornicles entirely dark or black; cubitus and anal veins of fore wings conspicuously outlined with fuscous borders.....*nervata* (Gillette) p. 277
- Fourth and fifth antennal segments uniformly light, fuscous, or black; cornicles ranging from black to greenish-brown; cubitus and anal veins of fore wings rarely conspicuously outlined with fuscous borders.....8
8. Cornicles without a flange (Fig. 122) at apex [alate form unknown but keyed out here on basis of apterous viviparous female].....*singularis* n. sp. p. 279
- Cornicles with a distinct flange at apex (Fig. 123).....9
9. Third antennal segment with few secondary sensoria, eight in type specimen (Fig. 305), arranged in a straight row.....*nebulosa* n. sp. p. 275
- Third antennal segment with numerous secondary sensoria, twenty to fifty or more (Fig. 307), arranged in a very irregular row10
10. Third antennal segment with from 22 to 29 secondary sensoria (Fig. 307); cornicles much longer than width of head through eyes and approximately as long as third antennal segment...*rossi* n. sp. p. 277
- Third antennal segment with from 38 to 54 secondary sensoria; cornicles slightly longer than width of head through eyes and shorter than third antennal segment.....*laingi* Mason p. 275

AMPHOROPHORA COSMOPOLITANA MASON

- Amphorophora cosmopolitana* Mason, Proceedings of the United States National Museum, Vol. 67, Art. 20, Sept. 23, 1925, p. 16.
Rhopalosiphum sonchi Davis, Journal of Economic Entomology, Vol. 3, No. 6, December, 1910, p. 495. *Misidentification.*

This widely distributed species has been recorded previously from Illinois under the name of *Rhopalosiphum sonchi* Oestlund by Davis (1910). It is widely distributed throughout the state on *Lactuca* and *Sonchus*. Mason (1925) has given a very complete summary of information in literature regarding this species and technical descriptions of all forms. It alternates between various species of *Ribes* and such plants as *Lactuca* and *Sonchus*, occurring on the former in spring and late fall and on the latter in summer.

From a study of the actual specimens involved, kindly loaned to us by Professor J. J. Davis, we have found that the Davis (1910e) record of *Rhopalosiphum sonchi* "from northern Illinois" refers to

this species and needs to be added to the bibliography of this species as given by Mason. It is very probable, too, that the record of *Siphonophora lactucae* Linn. of Thomas refers to a species of *Myzus* instead of to *cosmopolitana* as questionably placed by Mason.

Data associated with our Illinois viviparous specimens are as follows: Oak Park (Aug. 14), 1909; St. Joseph (Aug. 5), Urbana (Aug. 8, 15, 20, Sept. 26, Dec. 19), 1928; Cairo (June 22), Catlin (May 17), Edwardsville (Sept. 11), Galena (July 10), Mattoon (Sept. 11), Melrose Park (July 12), Newton (June 17), Oregon (July 11), Riverside (July 14), Rock Island (July 9), Urbana (July 19, Oct. 9, 15, 21), 1929. The specimens taken at Catlin (May 17), 1929, represent the spring generation and the specimens at Urbana (Oct. 21), 1929, the fall generation on *Ribes*. All other specimens taken on *Lactuca*, *Sonchus* sp., *Sonchus oleraceus*, and *Sonchus arvensis*.

AMPHOROPHORA LAINGI MASON

Amphorophora laingi Mason, Proceedings of the United States National Museum, Vol. 67, Art. 20, Sept. 23, 1925, p. 32.

This species is here recorded from Illinois for the first time. Mason (1925) has shown that American specimens previously determined as *A. ampullata* Buckton are distinct from the types of *A. ampullata* Buckton and, accordingly, has renamed the species. He gives descriptions of the apterous and alate viviparous females and accepts the descriptions of Van der Goot ((1915) as applying to the male and oviparous female. Very little is known about this species except that it attacks various genera of ferns.

We have taken it but once, by sweeping ferns at Starved Rock State Park, July 6, 1929.

AMPHOROPHORA NABALI (OESTLUND)

Rhopalosiphum nabali Oestlund, Fourteenth Annual Report of the State Geologist of Minnesota, March, 1886, p. 34.

This species has not been recorded previously from Illinois. Although we have taken it in only five scattered localities in the state, it probably occurs wherever its host is common. Slides of our material have been compared with cotypic material in the collection of Dr. O. W. Oestlund. Mason (1925) has described in detail the alate and apterous viviparous females. The species tends to congregate on the upper part of the stalk and flower heads of its host.

Data associated with our viviparous specimens, all collected on *Prenanthes alba*, are as follows: Choat (Sept. 28), Herod (Sept. 27), Makanda (Sept. 28), Oakwood (Oct. 17), Starved Rock State Park (Aug. 14, Sept. 10), 1929.

AMPHOROPHORA NEBULOSA new species

FIGS. 127, 164

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.56. Head, thorax, and abdomen essentially uniformly brown, with some lighter areas laterally. Cornicles brown with a trace of green; anal plate brown; cauda yellowish. First and second antennal segments concolorous with the

head, gibbous portion of first segment slightly darker than remaining portions; third antennal segment yellowish at base and slightly so near apex, whereas the portion covered by the sensorium is brownish; remaining segments uniformly yellowish. Basal portion of femora yellowish, shading gradually to dusky brown towards apex; tibiae yellowish with apices dusky brown; tarsae dusky brown. Veins of wings rather light in color, cubitus and anal veins slightly margined with fuscous. Beak yellowish, tipped with dark brown.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with comparative lengths as follows: III— .50; IV— .43; V— .36; VI— .16 plus .79. The secondary sensoria (Fig. 305) are eight in number, limited to the third antennal segment, and are arranged in a straight row about equally distant from the anterior and posterior ends of the segment. The primary sensorium on the sixth antennal segment is of interest because of the lack of marginal sensoria. The beak reaches just to the coxae of the mesothoracic pair of legs.

Thorax and appendages.—The second fork of media of fore wing is slightly closer to the margin of the wing than it is to the first fork; radial sector strongly bowed; stigma gray, rather short. The tarsi appear comparatively short, the second segment exclusive of claws being one-third the length of the cauda.

Abdomen.—Cornicles (Fig. 127) rather slender but gradually swollen, faintly imbricated, slightly shorter than third antennal segment, with a distinct flange at their apex; their length is .47. The cauda (Fig. 164) is about twice the length of the base of the sixth antennal segment, is distinctly constricted, and has two and three hairs on a side; its length is .30. The anal plate is rounded.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.13. Head, thorax, and abdomen brown as in alate viviparous female, prothorax with lateral margins and abdomen posterior to the cornicles lighter brown. Femora varying in color from yellowish to light dusky brown; tibiae almost uniformly brown, some perhaps a little darker towards the tip; tarsi brownish. Cornicles, cauda, and anal plate as in the alate viviparous female. Beak colored as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .41. Antennal segments with comparative lengths as follows: III— .39 to .43, average .41; IV— .24 to .24, average .24; V— .24 to .24, average .24; VI— .13 to .14, average .13 plus .50 to .54, average .52. Antennae without secondary sensoria; hair on the antennae exceedingly fine and short. The beak extends slightly beyond the coxae of the metathoracic pair of legs. Antennal tubercles poorly developed; in fact, many species belonging to the genus *Aphis* have the tubercles as well developed.

Thorax and appendages.—Tibiae of the first two pairs of legs subequal, a little less than five times the length of the base of the sixth antennal segment; hind tibiae much longer, almost twice as long as the terminal filament of the sixth antennal segment.

Abdomen.—Cornicles shaped as in alate viviparous female and either equal or subequal in length to the third antennal segment; average length, .39. Cauda one-third the length of the terminal filament, with two hairs on a side, but slightly constricted; average length, .17.

Holotype.—Alate viviparous female; Starved Rock State Park, Illinois, August 14, 1929, on *Poa*, (Frison and Hottes). Slide No. 10382. *Morphotype.*—Apterous viviparous female; same data as holotype. Slide No. 10383. *Paratypes.*—Two slides of pupae, nymph, and apterous viviparous female; same data as holotype. Slides Nos. 10384-10385.

The types of this species were found on a species of grass (*Poa*) growing on the ledges of a small canyon in Starved Rock State Park, Illinois. Apparently the closest ally of this new species is *A. nervata* (Gillette) from which it can be distinguished by its shorter antennal

tubercles, shorter terminal filament of the sixth antennal segment, and its wider head in proportion to length of cornicles. This species was submitted to Dr. P. W. Mason who confirmed our supposition that it was new.

AMPHOROPHORA NERVATA (GILLETTE)

FIG. 123

Rhopalosiphum nervatum Gillette, Canadian Entomologist, Vol. XL, No. 2, February, 1908, p. 63.

This species is here recorded from Illinois for the first time. The extremely limited distribution of its host plants in the state precludes this aphid from having a wide distribution. Mason (1925) has redescribed all the known forms; he states that in California this plant louse "seems to migrate between rose and *Arbutus*."

We have taken viviparous specimens of this species only once, at Beach, July 13, 1929, on *Arctostaphylos Uva-ursi*.

AMPHOROPHORA ROSSI new species

FIGS. 121, 177, 307

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 2.14. Head, first and second and extreme base of third antennal segments, and mesothorax a light brownish green; prothorax, metathorax, coxae, trochanters, abdomen, and anal plate except apical margin a light apple green; abdomen with a medial line and lateral margins a dark green, areas between lighter green, venter uniform dark green. Cornicles with translucent brownish green at base and with swollen area often fuscous; cauda light whitish green. Antennae beyond base of third segment almost black. Femora whitish green at base, shading to light brown at apex; tibiae light brown with a dark brown or black area at apices equal to three times length of tarsi; tarsi dark brown or black. Beak with basal segment whitish green, middle segment light brown, apical segment black. Wings hyaline; stigma, costa, and subcosta a light brown except that bases of latter two are whitish; veins almost of equal width, black. Eyes and base of ocelli brownish black.

Head and appendages.—Average width of head across eyes, .54. Antennal segments with comparative lengths as follows: III— .79 to .84, average .80; IV— .53 to .64, average .60; V— .44 to .59, average .51; VI— .13 to .16, average .14 plus .71 to .83, average .78. The secondary sensoria (Fig. 307) are restricted to the third segment; although not in a straight row, they are confined to one side of segment and extend its full length except for a distance equal to length of the second antennal segment; they number from 22 to 29 and average 26. The antennal tubercles are quite well developed. The beak extends slightly beyond the coxae of the second pair of legs.

Thorax and appendages.—The second segment of the tarsus, exclusive of claws, is about one-fourth the length of the cauda or as long as the second antennal segment. The second fork of media of fore-wing in relation to the first fork and margin of wings is variable.

Abdomen.—The cornicles (Fig. 121), .64 in length, slightly longer than the fourth antennal segment, only moderately swollen, the swelling being slightly more pronounced on the inner margin; apical flange quite well developed; the area immediately anterior to the flange very faintly imbricated. The cauda (Fig. 177), .34 long, is twice the length of the base of the sixth antennal segment, with a slight indication of a constriction just beyond the middle and four hairs on a side. The anal plate is quite long for its width and rather narrowly rounded at its apex.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Size and general color.—Length of single specimen, 2.00. Head, including first two antennal segments, and borders of prothorax a whitish green. Remainder of thorax, anal plate, coxae, trochanters, and basal third of femora apple-green. Abdomen, except for dark green medial longitudinal stripe, a whitish green. Cornicles pale translucent brownish green, with extreme apex dark brown. Third, fourth, and fifth antennal segments greenish brown with the extreme apex dark brown; sixth segment entirely dark brown. Apices of femora and all of tibiae light brown, apices of tibiae darker; tarsi dark brown. Beak as in the alate viviparous female. Eyes brownish black.

Head and appendages.—Average width of head across eyes, .53. Proportional length of antennal segments as follows: III— .54; IV— .53; V— .29; VI— .12 plus .37. Secondary sensoria absent. Fifth and sixth antennal segments imbricated, others smooth. Primary sensorium on sixth antennal segment with a group of marginal sensoria at one side. Antennal tubercles strongly developed. Hairs on head and antennae knobbed. Beak reaching to midway between meso- and metathoracic coxae.

Thorax and appendages.—Tibiae with hairs on basal half shorter than width, those on apical half subequal to width. Hairs on appendages both normal and knobbed.

Abdomen.—Cornicles .47 in length, distinctly more swollen on inner than on outer margin, flange at apex poorly developed. Cauda .22 in length, stout, broadly rounded at apex, not constricted, with three pairs of inwardly directed hairs on each side. Anal plate normal.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 2.30. Differing from stem mother in color only by being a slightly lighter shade of green.

Head and appendages.—Average width of head across eyes, .58. Antennal segments with comparative lengths as follows: III— .79 to .84, average .80; IV— .53 to .64, average .60; V— .44 to .59, average .51; VI— .13 to .16, average .14 plus .71 to .83, average .78. Secondary sensoria limited to the third antennal segment and numbering from one to two. The beak extends to the middle of the coxae of the metathoracic pair of legs.

Thorax and appendages.—Similar to appendages of alate viviparous female, except for lack of wings.

Abdomen.—Cornicles .78 in length, almost always slightly more than twice the length of cauda, about equal to the length of the third antennal segment, with an average length of .72. Cauda and anal plate shaped as in alate viviparous female; cauda with an average length of .32.

Holotype.—Alate viviparous female; Urbana, Illinois, May 3, 1930, on *Geum canadense*, (Frison and Ross). Slide No. 10358. *Morphotype.*—Apterous viviparous female (fundatrix); Same data as for holotype. Slide No. 10360. *Morphotype.*—Apterous viviparous female (virgogenia); Same data as for holotype. On slide with one paratypic apterous viviparous female. Slide No. 10359. *Paratypes.*—Thirty-eight slides of alate and apterous viviparous females, pupae, and nymphs; all collected in Illinois by T. H. Frison, F. C. Hottes, and H. H. Ross from *Geum canadense*. Other data are as follows: Muncie (October 6, 1928) and Urbana (May 3, 22 and July 26). Slides Nos. 10361-10380 and others unnumbered.

This species was submitted to Dr. P. W. Mason for examination because it could not be satisfactorily determined to species in the key published in his revisional paper of this genus (1925). Dr. Mason reported that the species was unknown to him. The alate viviparous female keys to *A. nabali* (Oestlund) in Dr. Mason's paper, but differs from that species by the absence of secondary sensoria on the fourth and fifth antennal segments. The apterous viviparous females run in Dr. Mason's key to *A. evansi* Theobald which, judging from the non-

swollen cornicles, is probably not an *Amphorophora*. *A. laingi* Mason is apparently another closely allied species from which it differs by the characters given in our key.

AMPHOROPHORA SENSORIATA MASON

Amphorophora sensoriata Mason, Proceedings of the Entomological Society of Washington, Vol. 25, No. 9, December, 1923, p. 189.

This species has not previously been reported from Illinois. It may be found by examining the stems of new shoots of its host. Our records indicate that it is generally distributed throughout the state. The species quickly drops from its host when distributed, and it is believed to have no alternate host, although the sexual forms are as yet unknown. Technical descriptions of the viviparous forms are given by Mason (1923 and 1925).

Data associated with our viviparous specimens, all collected on *Rubus* sp., are as follows: Bloomington (Aug. 14), Chicago (July 13), Galena (July 10), Jonesboro (Sept. 28), Lisle (July 14), Mahomet (Aug. 17), Morrison (July 9), Oakwood (July 22), Oregon (July 11), Pana (Sept. 10), Richmond (July 12), Starved Rock State Park (Aug. 14), Urbana (July 22), 1929.

AMPHOROPHORA SINGULARIS new species

FIGS. 122, 306

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate 1.47. Head light brown; thorax and abdomen brownish-yellow (probably badly faded), abdomen with small clear areas at base of cornicles; cornicles very dark brown; cauda and anal plate light brownish, approximately concolorous with abdomen. First and second antennal segments concolorous with the head, third antennal segment with basal part anterior to sensorium yellowish and remainder of segment dark brown, remaining three apical segments dark brown. The coxae, trochanters and basal three-fourths of femora are yellowish, apical fourth of femora dark brown; tibiae alternately marked with yellow and brown, yellowish at their base for a distance about equal to the length of the second antennal segment, then dark brown for a distance about equal to one-half of the length of the third antennal segment, then becoming yellowish again for a distance about equal to the length of the cornicles, and finally terminating as brownish to the tarsi—a distance about equal to half the length of the cornicles; tarsi brownish. Beak yellowish, except for the last two segments, which are a light-brown.

Head and appendages.—Average width of head across eyes, 44. Antennal segments with comparative lengths as follows: III—54; IV—51; V—44; VI—.14 plus .90. The third antennal segment (Fig. 306) has a single sensorium situated about the length of the first antennal segment from its base at a point where the brown color begins. The beak reaches just beyond the coxae of the mesothoracic pair of legs.

Thorax and appendages.—The tibiae of the pro- and mesothoracic pairs of legs are about equal to twice the length of the fifth antennal segment; the tarsi comparatively short, without the claws being equal to or slightly longer than the second antennal segment.

Abdomen.—Cornicles (Fig. 122) .47 in length, approximately sub-equal in length to the third antennal segment, very gently and gradually swollen, ending very abruptly and without a flange, very faintly imbricated. Cauda .29 in length, two-thirds as long as the cornicles, comparatively narrow, and with one to two hairs on a side. Anal plate roundly pointed.

Holotype.—Apterous viviparous female; Golconda, Illinois, October 13, 1928, on unknown species of grass (Frison and Hottes). Slide No. 10381.

This species is suggestive of our new species *Amphorophora nebularis*, from which it may be separated in the apterous viviparous females by the single sensorium on the third antennal segment, the difference in the comparative lengths of the antennal segments, the differently colored legs, and the shorter beak. In Dr. P. W. Mason's (1925) revision of the genus *Amphorophora* this species keys to *A. formosana* Takahashi from Formosa. It differs from the original description of *formosana* in that the third, fourth, fifth, and sixth antennal segments are very much shorter and more nearly equal and the cornicles are about uniformly swollen on both sides.

AMPHOROPHORA SOLANI (THOMAS)

Megoura solani Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 73.

This species is represented in the Survey collection by a single specimen, the type, taken by Thomas at Carbondale, Illinois. It was collected on tomato in association with other specimens including pupae—an indication that its association with this host was not accidental.

Data associated with this slide (No. 2772) are as follows: Carbondale (May 26), 1878, on *Tomato occidentalis* (= *Lycopersicon esculentum*?) collected by C. Thomas.

AMPHOROPHORA VACCINII MASON

FIG. 126

Amphorophora vaccinii Mason, Proceedings of the United States National Museum, Volume 67, Article 20, p. 67.

This species is here reported from Illinois for the first time. Our record is based upon a single collection of viviparous specimens at Grand Detour (May 15-16, 1930, on *Vaccinium vacillans*. Mason (1925) has given technical descriptions of the viviparous and oviparous females.

GENUS CAPITOPHORUS VAN DER GOOT

(SUBGENERA CAPITOPHORUS VAN DER GOOT AND CRYPTOMYZUS OESTLUND)

Key to the Species of the Genus Capitophorus

1. Cornicles much shorter than fourth antennal segment.....2
- Cornicles approximately as long as, or longer than, fourth antennal segment3
2. Secondary sensoria numerous on fourth antennal segment (about 24), a few secondary sensoria on fifth antennal segment; cornicles swollen.....*poae* (Gillette) p. 290
- Secondary sensoria lacking or few on fourth antennal segment (0 to 5), no secondary sensoria on fifth antennal segment; cornicles not swollen (Fig. 128).....*patonkus* n. sp. p. 287

3. Secondary sensoria restricted to third antennal segment.....4
- Secondary sensoria at least on third and fourth antennal segments6
4. Cornicles much longer than fourth antennal segment; hind tibiae almost uniformly dark.....*corambus* n. sp. p. 281
- Cornicles shorter or approximately the same length as the fourth antennal segment; hind tibiae mostly light colored with apices dark and contrasting.....5
5. Width of head through eyes much wider than length of cornicles; cornicles dark; secondary sensoria on third antennal segment averaging over 30.....*tetrarhodus* (Walker) p. 291
- Width of head through eyes and cornicles of about equal length; cornicles, except for extreme apices, almost concolorous with abdomen; secondary sensoria on third antennal segment averaging less than 30.....*minor* (Forbes) p. 284
6. Cauda blunt or rounded at apex (Figs. 163, 167).....7
- Cauda tapering to point at apex (Fig. 174).....8
7. Terminal filament of sixth antennal segment longer than third and fourth antennal segments together; secondary sensoria on fifth antennal segment ranging from 7 to 12.....
- *ribis* (Linnaeus) p. 290
- Terminal filament of sixth antennal segment shorter than third and fourth antennal segments together; secondary sensoria on fifth antennal segment ranging from 0 to 2....*pakansus* n. sp. p. 286
8. Apical portion of cornicles distinctly swollen.*gillettei* Theobald. p. 284
- Apical portion of cornicles not swollen.....9
9. Secondary sensoria numerous on fourth antennal segment and ranging from none to many on the fifth; cornicles much longer than width of head through eyes or length of fourth antennal segment; on *Cirsium* or *Elaeagnus*.....*flaveolus* (Walker) p. 282
- Secondary sensoria few on fourth antennal segment and usually lacking on the fifth; cornicles shorter than or about as long as width of head through eyes or length of fourth antennal segment; on *Rosa* or *Fragaria*.....10
10. Apterous forms with conspicuous capitate setae scattered over entire body; third antennal segment with secondary sensoria widely scattered and numbering about thirty.....
- *fragaefolii* (Cockerell) p. 283
- Apterous forms with conspicuous capitate setae restricted almost entirely to head and anal regions of abdomen; third antennal segment with secondary sensoria less scattered and numbering about twenty.....*minor* (Forbes) p. 284

CAPITOPHORUS CORAMBUS new species

FIGS. 125, 174, 259, 260

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.25. Head and thorax yellowish brown. Abdomen light yellowish green with brownish markings around base of cornicles and posterior to them. Cauda and anal plate brownish. Cornicles with basal half yellowish brown, shading to darker brown towards the apex. Antennae with first two segments concolorous with head and extreme base of flagellum pale yellowish, remainder of flagellum uniform blackish brown. Femora with about the basal two-thirds yellowish and the remaining portion brown. Tibiae and tarsi usually fairly dark dusky brown, sometimes apical portions of tibiae darker than the base. Beak light yellowish brown with the extreme tip dark brown. Stigma of fore wings light dusky brown with the posterior margin darkest, veins brown, cubital and anal veins darkest, veins failing to reach margin of wing but ending in a brownish suffusion, that of the anal veins being the largest and darkest.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III— .69 to .73, average .71; IV— .40 to .43, average .42; V— .37 to .40, average .39; VI— .10 plus .86. Secondary sensoria (Fig. 260) restricted to third antennal segment, irregularly arranged but distinctly more crowded on one side, in form rather tuberculate and varying in number from 31 to 36. Primary sensorium on sixth antennal segment with a group of about 5 marginal sensoria to one side. Hair on third antennal segment slightly knobbed, hair on remaining antennal segments blunt at the tip but not distinctly knobbed; base of hairs distinctly lighter in color than remaining portion of antennae and often suggestive of sensoria. Antennal tubercles well developed. Median portion of head between antennae with a prominent process from which capitate hairs arise. Beak reaching beyond base of mesothoracic coxae.

Thorax and appendages.—Hairs on tibiae short, rather spine-like, not longer than, if as long as, the width of segment; capitate hairs rare. Stigma of fore wings narrow, radial sector strongly curved, second fork of media distinctly closer to margin of wing than to the first fork.

Abdomen.—Cornicles (Fig. 125) averaging .55 in length, poorly imbricated throughout their length, somewhat constricted in the middle so that they have the appearance of being slightly swollen beyond the middle; the apex with a poorly developed rim. Cauda (Fig. 174) a little less than half as long as the cornicles, averaging .23 in length, not constricted or but very slightly so, with four long non-capitate hairs on each side. Hairs on remaining portion of abdomen scarce but usually somewhat capitate. Anal plate inconspicuous in our specimens but apparently normal.

APTEROUS VIVIPAROUS FEMALE

Described from one poorly mounted specimen; hence no general description will be given except for general measurements and a few other very obvious facts.

Length 1.21. Width of head across eyes, .44. Antennal segments with the following comparative lengths: III— .64; IV— .36; V— .33; VI— .10, terminal filament missing. Third antennal segment with nine secondary sensoria (Fig. 259) on basal half arranged in an irregular row. Cornicles .60, cauda .29 in length. Cornicles very similar to those of alate viviparous female, but perhaps slightly thicker. Cauda distinctly spatulate, with two hairs on each side. Hairs on body and antennae capitate, remaining hairs spine-like.

Holotype.—Alate viviparous female; Galena, Illinois, July 10, 1929, on *Rosa* sp., (Frison and Hottes). On slide with nymphs. Slide No. 10657. *Morphotype.*—Apterous viviparous female; same data as holotype. On slide with paratyptic alate viviparous female. Slide No. 10658.

This species is probably most closely allied to *C. tetrarhoda* (Walker), from which it may be separated by the more swollen and longer cornicles, the differences in comparative lengths of antennal segments, the length of the beak in the alate viviparous female, and the presence of secondary sensoria on the third antennal segment in the apterous viviparous female.

CAPITOPHORUS FLAVEOLUS (WALKER)

Aphis flavcola Walker, Appendix to the Zoologist for 1849, Vol. VII, p. lv. *Myzus braggii* Gillette, Canadian Entomologist, Vol. XL, No. 1, January, 1908, p. 17. *New synonymy.*

This species has not been previously recorded from Illinois. We have placed *Myzus braggii* Gillette as a synonym of this species because the identical material, kindly determined for us as *flaveolus* by Dr. Theobald, has been compared by Miss Palmer with cotypes of *braggii*

and declared to be the same. All references to *M. clacagni* Del Guercio and *P. galvopsidis* Kalt. by Davis (1908c, 1911b) evidently refer to *C. gillettei* Theobald, because the cornicles are stated and figured as having the apical portion swollen.

C. flavcolus over-winters on Russian olive (*Elacagnus*) and in summer occurs on thistle (*Cirsium*). The best general accounts and descriptions of this insect are given by Gillette (1915) and Theobald (1926).

Data associated with our viviparous specimens are as follows: Catlin (Sept. 27), Champaign (Oct. 16), Herod (Oct. 12, Nov. 29), Urbana (Sept. 26, Oct. 19), 1928; Choat (Sept. 28), Edwardsville (Sept. 11), Herod (Sept. 27), Jonesboro (June 23), Lisle (July 14), Macomb (May 5), Oakwood (Aug. 18, Sept. 22), Oregon (July 11), Rock Island (July 7), Urbana (May 9, Oct. 14), 1929. Collected on *Cirsium lanceolatum*, *Cirsium* sp., and *Elacagnus* sp.

CAPITOPHORUS FRAGAEFOLII (COCKERELL)

FIG. 320

Myzus fragaeifolii Cockerell, Canadian Entomologist, Vol. XXXIII, No. 4, April, 1901, p. 101.

Myzus fragariae Theobald, Entomologist, Vol. XLV, No. 591, August, 1912, p. 223. *New synonymy*.

This is the species referred to by most American writers on aphids, probably including Davis (1910e), as *M. rosarum* Kaltenbach. It is not that species, however, because *rosarum*, according to the descriptions of Kaltenbach (1843) and Theobald (1926), has slightly swollen cornicles and differs in other respects. As shown under the discussion of *C. minor* (Forbes), this form is entitled to specific rank, and *fragaeifolii* (Cockerell) seems to be the oldest available name. The viviparous females are well described by Theobald (1926) and the sexual forms by Davidson (1914a).

Although *fragaeifolii* was originally described from material taken on *Fragaria*, we believe that the same species also occurs on *Rosa* and *Potentilla*. At any rate, we have been unable to separate certain material taken in Illinois on these hosts; specimens from all three plants agree with typic specimens of *fragaeifolii* loaned to us by the U. S. National Museum.

Myzus fragariae Theobald is placed in the synonymy of *fragaeifolii* because of determinations of Theobald, who named certain of our slide mounts from *Potentilla* as *fragariae*. These specimens seem to us to be identical with specimens of *fragaeifolii*.

Data associated with our material are as follows: Antioch (June 15), Galena (June 26), Havana (June 21), Ogden (July 8), Oregon (June 28), Pekin (June 20), Urbana (May 28, 31, July 10, Sept. 11, Oct. 22, Nov. 11), 1928; Beach (July 13), Edwardsville (Aug. 11), Galena (July 10), Lewistown (May 4), Macomb (May 5), Urbana (April 22), 1929; Oregon (May 16), Starved Rock State Park (May 13), Urbana (May 20, June 13, July 12, Nov. 16, 20, 21), 1930. Collected from *Rosa rugosa*, *Rosa* sp., *Potentilla monspeliensis*, *Potentilla* sp., and *Fragaria* sp. Mating sexual forms were found on November 11.

CAPITOPHORUS GILLETTEI THEOBALD

Fig. 4

Capitophorus gillettei Theobald, The Plant Lice or Aphididae of Great Britain, Vol. I, London, 1926, p. 238.

This species (Fig. 4) has been previously recorded from Illinois by Davis (1910b) under the name of *Phorodon galeopsidis* Kalt. It over-winters on *Elaeagnus* sp., from which it migrates in spring or early summer to *Polygonum* sp., where it remains until time to remigrate in fall to *Elaeagnus*. All forms except the oviparous female have been described by Theobald in the original description.

The data associated with our Illinois viviparous specimens are as follows: Catlin (Sept. 27), Champaign (Oct. 16), Danville (Sept. 18), Elizabethtown (Oct. 12), Golconda (Oct. 13), Muncie (Oct. 6), 1928; Catlin (May 17), Edwardsville (Sept. 11), Urbana (Oct. 7-14), 1929; Oakwood (Oct. 22), 1930. Collected on *Elaeagnus* sp., *Polygonum hydropiper*, *Polygonum* sp., and *Euphorbia marginata*. The record from *Euphorbia* represents a capture of alates which were probably there as a result of drifting. The Illinois localities and dates of the Davis (1910) records are as follows: Oak Park (Sept. 11-27 and Oct. 10, 12, 27, 1909), and Urbana (Aug. 11, 1909).

CAPITOPHORUS MINOR (FORBES)

Siphonophora minor Forbes, Thirteenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1884, p. 101.

In view of the fact that we have found two species of *Capitophorus* on strawberry in Illinois, and miscellaneous descriptions of species from this host in literature, a decision regarding the correct name to use for this species has been beset with difficulty. Through the kindness of Professor Davis and Mr. Mason, slides with types of *Myzus porosus* Sanderson (1900), *Myzus fragaefolii* Cockerell (1901), and *Macrosiphum fragariae* var. *immaculata* Riley (1875) were sent to us for examination. A determination of one of our slides as *Capitophorus fragariae* Theobald (1912), by Dr. Theobald, has also aided.

Our study of these typic slides shows that the *Myzus porosus* Sanderson belongs in the group for which we are using the generic name of *Myzus*. It is similar to a species which we have taken on rose and which we were considering as new until we saw these typic slides. Hence, this species, originally described from strawberry, does not enter into the synonymy of *Capitophorus*.

The typic slide of *M. fragariae* var. *immaculata* Riley, also described from strawberry, is in such poor condition that it is doubtful if the species can ever be placed. The frontal projections of the head are sufficient to show it is a *Macrosiphum*, and the cornicles are reticulate. This name, therefore, is also removed from consideration.

Typic slides of *Myzus fragaefolii* Cockerell, with both alate and apterous specimens, prove this species to be a true *Capitophorus*. The apterous forms have the entire body covered with numerous capitate or globose hairs, thus differing from *Capitophorus minor* (Forbes). The alates are very similar to *minor*, but apparently differ in secondary sensoria of third antennal segment. Since we have seen two cotypic slides of *fragaefolii* in two collections, one slide of which is in very

poor condition and not associated with apterous forms, we are designating a slide in the collection of the United States National Museum as the *lectotypic slide*. Data associated with this slide are as follows: "Jerome, Arizona, December 17, 1900, on strawberry, type of *Mysus fragaefolii* Cockerell, slide 9337."

A determination of a slide in our possession as *C. fragariae* Theobald (1912), by Theobald, indicates that *fragariae* is a synonym of *fragaefolii* (Cockerell) and not of *minor* (Forbes). This is also indicated by his description of the apterous forms.

The *Siphonophora minor* Forbes, with capitate hairs restricted to head and anal regions of the apterous forms, remains as a valid species. Slide No. 3158 in the Survey collection is the *lectotypic slide*.

Since the male and apterous oviparous female have not previously been described, descriptions of these forms are here presented.

Records associated with our Illinois material are as follows: Normal (June 21, 1883; Kankakee (June 29, July 15), Muncie (Nov. 22), Urbana (July 10), 1928; Oakwood (Oct. 17), Savoy (April 18), Urbana (April 17, May 22), 1929; Urbana (April 8, May 20), 1930. All specimens collected on *Fragaria* sp. Sexual forms taken at Oakwood (Oct. 17), 1929.

ALATE MALE

Average length from vertex to tip of anal plate, .71. Head dark brownish; thorax dusky brown with some yellowish; abdomen yellowish, with brownish spots on dorsum and lateral portions; cornicles, cauda, and anal plate, dusky. Antennae uniform brown. Femora yellowish at the base, remaining portion brown; tibiae light brownish, with the apical portions darker. Veins brown, posterior margin of wing in vicinity of anal vein brown. Genitalia dark brown.

Average width of head across eyes, .31. Comparative lengths of antennal segments as follows: III— .44 to .49, average .47; IV— .27 to .31, average .28; V— .26 to .31, average .29; VI— .10 to .13, average .11 plus .49 to .60, average .54. Secondary sensoria present on the third, fourth, and fifth antennal segments, confined largely to one side of segment, those on third more scattered than those on fourth and fifth, distributed as follows: III— 16 to 22, average 20; IV— 6 to 8; V— 4 to 8, average 7. Primary sensorium with about four marginal sensoria at the side. Beak reaching to middle of mesothoracic coxae. Second fork of media closer to margin of wing than to first fork. Cornicles .19 long, straight, slightly imbricated, but not reticulated. Cauda .08 long, with about three hairs on a side.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 1.20. Body yellowish with a slight brownish tinge on the head. Cornicles, cauda, anal plate, and legs pale yellowish except tarsi, which are dusky. Antennae brownish except for extreme base of third segment and small ring-like areas at the apical portions of the third, fourth, and fifth segments, which are yellowish. Capitate hairs present on vertex of head, absent or very poorly developed on the second and third antennal segments, numbering about 2 on the first, fairly abundant on posterior regions of abdomen, but rarely found on other parts of the body. Average width of head across eyes, .30. Comparative lengths of antennal segments as follows: III— .33 to .37, average .35; IV— .17 to .24, average .21; V— .17 to .26, average .22; VI— .10 to .13, average .11 plus .49 to .66, average .54. Secondary sensoria absent. Beak reaching to about the middle of the metathoracic coxae. Cornicles .33 long, in shape similar to those of viviparous female. Cauda .16 long, with about two hairs on a side. Basal half of tibiae swollen, with about 35 sensoria.

Allotype.—Alate male; Slide No. 8408, Oakwood, Illinois, October 17, 1929, on *Fragaria* sp., (Frison and Ross). On slide with oviparous females. *Morphotype*.—Apterous oviparous female; Slide No. 8407, same data as allotype. On slide with male and oviparous female.

CAPITOPHORUS PAKANSUS new species

FIGS. 119, 163, 257, 258

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.50. Head and thorax essentially green shading to brown, the brown dominating on dorsum and venter and the green on the lateral portions; abdomen yellowish-green with a median brownish rectangular patch on the dorsum. Cornicles lighter in color than the abdomen for about half their length, remaining portion light fuscous; cauda and anal plate concolorous with the greenish part of the abdomen. First and second antennal segments concolorous with head, third antennal segment light yellowish-green at extreme base, remaining portions of third antennal segment and the two following segments dark brown, sixth antennal segment brown but much lighter, especially the terminal filament. Coxae somewhat fuscous, trochanters and bases of femora pale greenish, remainder of femora and fourth-fifths of tibiae pale yellowish-brown, apices of tibiae and tarsi dark brown. Beak greenish except for the extreme tip, which is brownish. Stigma slightly fuscous; veins brownish, the anal vein darkest, posterior margin of wing in the vicinity of the anal vein also brownish.

Head and appendages.—Average width of head across eyes, .37. Antennal segments with comparative lengths as follows: III— .37 to .43, average .40; IV— .26 to .30, average .27; V— .11 to .26, average .20; VI— .07 to .09, average .08 plus .57 to .60, average .58. Secondary sensoria (Fig. 257) present on the third and fourth antennal segments and sometimes on the fifth. The secondary sensoria distributed as follows: III— 37 to 44, IV— 18 to 20; V— 0 to 2. Sensoria widely scattered on the third and fourth antennal segments, the third segment being somewhat tuberculate in appearance. Hair on the antennae exceedingly scarce, exceptionally short and fine although blunt at the tip. Antennal tubercles very poorly developed, the first antennal segment gibbous on the inner margin but no more so than in the genus *Myzus*. Beak slender, particularly the terminal segment, extending to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Stigma long, narrow, and sharply pointed; second fork of media closer to the margin of the wing than it is to the first fork. Brownish areas at the apices of the tibiae distinctly swollen; hairs on the legs not capitate but pointed at the tip, increasing in length from the base to the apex of the segment, and declinate.

Abdomen.—Cornicles (Fig. 119) subequal to, or very slightly longer than, the third antennal segment, averaging .43 in length, of almost uniform thickness throughout their length except that they are slightly thicker at their apices; without a distinct flange. Anal plate normal; cauda (Fig. 163) short, about as long as the base of the sixth antennal segment, wide and blunt but smaller than the cauda of a typical species of the subgenus *Anuraphis*.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.68. Head and thorax essentially greenish shading to brown, the brown dominating on dorsum and venter and the green on lateral portions. Abdomen, instead of having a single median spot on the dorsum, has three oblong transverse spots anterior to the cornicles. Antennae brownish with the exception of the extreme base of the third antennal segment and the terminal process, which are lighter. Legs and cornicles very similar in color to the same structures of the alate viviparous female. Cauda and anal plate more fuscous than the abdomen. Wings similar to the wings of the alate viviparous female. Opercula dark brown.

Head and appendages.—Average width of head across eyes, .37. Antennal segments with comparative lengths as follows: III— .40 to .43; average .41; IV— .27 to .31, average .29; V— .26 to .30, average .27; VI— .07 to .09, average .08 plus .54 to .59, average .55. Secondary sensoria (Fig. 258) scattered, on third, fourth, and fifth segments; so little variation in

their numbers that averages are not given; on one specimen distributed as follows: III—42; IV—23; V—15. Antennal tubercles, first antennal segments, and the beak similar to the same structures in the alate viviparous female.

Thorax and appendages.—Similar to those of the alate viviparous female.

Abdomen.—Cauda, anal plate, and cornicles essentially similar to the same structures of the alate viviparous female; cauda about one-fourth the length of the cornicles, averaging .09 in length, with fine hair on posterior margin. Opercula with numerous short hairs.

Holotype.—Alate viviparous female; Urbana, Illinois, October 17, 1929, on *Inula royaleana*, (Frison and Ross). Slide No. 10843. *Allotype.*—Alate male; same data as for *holotype*. Slide No. 10844. *Paratypes.*—Thirty-one slides of alate viviparous females, males and pupae. Same data as for *holotype* except some specimens collected on October 15. Slides Nos. 10845-10864 and others unnumbered.

This species is extremely closely allied to *Capitophorus inulae* (Walker) of Europe and may eventually be shown to be the same. It differs from *inulae* as described in rather meager descriptions in having comparatively longer antennae, the fourth antennal segment longer than the fifth instead of equal as stated by Van der Goot, and the comparative length of the cauda in relation to the length of the cornicles—the cauda being about one-sixth the length of the cornicles rather than one-fourth the length of the cornicles. It differs from *Capitophorus similis* Van der Goot, another closely allied species, in the lack of black spots at the bases of the cornicles, the relatively larger number of sensoria, and comparative lengths of fourth and fifth antennal segments.

On one slide there is a specimen of an apterous viviparous female which is apparently immature and in such condition that it is not described.

This species was exceedingly numerous under the larger leaves of a few specimen plants of *Inula royaleana* in the floricultural gardens of the University of Illinois.

CAPITOPHORUS PATONKUS new species

FIGS. 82, 128, 169, 272, 274

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.50. Head, thorax, and abdomen with numerous spatulate hairs. Head yellowish green, with fuscous area about ocelli. First and second antennal segments concolorous with head; remaining antennal segments fuscous or black except extreme basal portion of third, which is a yellowish green. Thorax, abdomen, cauda, anal plate an apple green; cornicles at base concolorous with abdomen, gradually shading to brown or fuscous at apex. Legs concolorous with body except that apices of tibiae, all of tarsi, and dorsal portions of femora are brownish or black. Beak greenish, with terminal segment dark brown or black. Wings with costal margin (costal, subcostal, and base of radial veins) slightly greenish, rest of veins distinctly dark brown. Eyes black. Adult with hoary appearance in life due to capitate hairs.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with comparative lengths as follows: III— .57 to .69, average .62; IV— .53 to .60, average .57; V— .50 to .56, average .53; VI— .14 to .17, average .15 plus .80 to 1.00, average .91. Secondary sensoria (Fig. 274) confined to the third and fourth antennal segments, sometimes sensoria

lacking on fourth segment, numbering from 13 to 18 and averaging 15 on third segment, numbering from 0 to 5 and averaging 2 on fourth segment, arranged in an irregular row. Primary sensorium on sixth segment with a group of small marginal sensoria at one side. Beak sometimes extending as far as coxae of metathoracic legs, but usually less than this distance; terminal segment extremely pointed. Head with antennal tubercles well developed (Fig. 82), with four capitate hairs on the anterior median portion.

Thorax and appendages.—Fore wing with stigma rather short and bluntly pointed; second fork of media closer to margin of wing than to first fork, most veins not reaching margin of wings, posterior margin thickened and dark where anal vein reaches wing.

Abdomen.—Cornicles (Fig. 128) shorter than cauda, averaging .16 in length, sides straight and but slightly tapering from base to apex, which is without conspicuous flange; imbricated entire length. Cauda (Fig. 169) gradually tapering from base to rounded apex, averaging .24 in length, with two sharply pointed curved hairs on each side.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.31. Head, thorax, and abdomen with numerous heavy spatulate hairs. Head and first two antennal segments yellowish green; thorax, abdomen, anal plate, and cauda an apple green except that dorsum of abdomen has a darker green medial and a lateral stripe on each side; cornicles essentially concolorous with abdomen except that apex is slightly fuscous. In life the entire body has a hoary appearance due to the bulbous pale setae. Third antennal segment yellowish green at extreme base, remaining portion of segment and following segments essentially dusky brown to almost black. Legs yellowish-green, with the exception that apices of the tibiae, all of tarsi, and sometimes dorsal portions of the femora are dusky brown. Beak yellowish-green, except last two segments, which are dusky or brownish. Eyes black.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with comparative lengths as follows: III— .39 to .60, average .52; IV— .27 to .57, average .40; V— .30 to .40, average .35; VI— .09 to .13, average .12 plus .36 to .76 average .58. Secondary sensoria (Fig. 272) two to six, on third antennal segment, never farther removed from the base of the segment than the length of the second segment of the hind tarsus exclusive of claws. Beak varying in length, in some specimens reaching to the coxae of the metathoracic pair of legs and in others reaching only to mesothoracic coxae. Hair on antennae not spatulate, exceedingly short, and not equaling the width of the segment.

Abdomen.—Cornicles exceedingly short for a species of *Capitophorus*, averaging .10, about as long as base of sixth antennal segment or one-half the length of the cauda, tapering somewhat to the tip, which is without a flange; indistinctly imbricated. Cauda long, averaging .21, distinctly constricted beyond base, with two non-spatulate hairs on a side and a single median hair a little posterior to the base of the last lateral pair. Anal plate rounded, not reaching to constricted portion of the cauda, four non-spatulate hairs on rounded posterior margin.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length (two specimens) from vertex to tip of anal plate, 1.61. Head, thorax, and abdomen with numerous spatulate hairs. Head, thorax, and most of abdomen colored as in apterous viviparous females. Cornicles, cauda, anal plate, and patch ventral to anal plate, dusky brown. First and second antennal segments dusky brown, darker than the head, in color, remainder of antennae either uniformly dark brown or with the third antennal segment somewhat lighter than the others. Legs darker than in the viviparous female; femora concolorous with body at the base, remaining portions light dusky green, to almost brownish dorsally; tibiae dusky greenish-yellow, apical portion, and especially portion

covered by sensoria on hind tibiae, darker and somewhat brownish; tarsi brownish.

Head and appendages.—Average width of head across eyes, .41. Antennal segments with comparative lengths (two specimens) as follows: III—.43 to .44; IV—.30 to .34; V—.31; VI—.10 plus .53. Secondary sensoria restricted to an area near the base of third antennal segment equal to the length of the hind tarsi exclusive of claws; from two to three in number, arranged in a straight row. Beak similar to that of the apterous viviparous female.

Thorax and appendages.—Posterior tibiae slightly swollen near base for about one-fourth their length, swollen area with from twelve to eighteen sensoria.

Abdomen.—Cornicles essentially shaped as in apterous viviparous female but uniformly dusky, averaging .08 in length; cauda and anal plate also similar to the same structures in apterous viviparous female but dusky throughout length.

ALATE MALE

Size and general color.—Length of single specimen from vertex to tip of anal plate, 1.31. In color entirely unlike that of apterous viviparous female (may be due to poor preparation), being a very deep brown, darkest on the head, thorax, and posterior region of the abdomen; cornicles dusky brown, not as dark as rest of body; cauda darker than the cornicles and brownish black. Antennae uniformly deep brown with the exception of the extreme base of the third segment and apical one-fourth of the terminal filament, which are lighter. Legs brown with the exception of the bases of the femora, particularly fore femora, which are dusky yellow; apices of tibiae, knees of femora, and tarsi somewhat darker than the rest. Hairs on inner sides of tibiae longer, distinctly more spine-like than remaining hairs on tibiae. Wings dark, but their color is probably somewhat accentuated by the very dark brown veins and the dark stigma.

Head and appendages.—Antennal segments of single specimen with comparative lengths as follows: III—.54; IV—.57; V—.44; VI—.16 plus 1.06. Secondary sensoria present on third, fourth, and fifth segments; small, usually confined to one side of the segment, irregularly arranged except on fifth segment where they are somewhat more regular; they number as follows: III—28; IV—26; V—17. The dusky brown beak reaches the coxae of the mesothoracic pair of legs, its extreme tip is darker than the rest.

Thorax and appendages.—Stigma of fore wings comparatively narrow and not sharply pointed; second fork of media is closer to the margin of the wing in one wing and closer to the first fork of the media in the other. Posterior margin of fore wing much thickened near point of connection with anal vein.

Abdomen.—Cornicles of uniform thickness throughout; feebly though distinctly imbricated, with a poorly developed rim; subequal in length to the base of sixth antennal segment or the cauda. Cauda probably constricted near the base, but in the manner in which specimen is mounted on the slide this is merely suggested; with four lateral and two somewhat more dorsal hairs. Anal plate indistinct due to mounting of specimen. Opercula very dark brownish-black, covered with rather long hook-shaped hairs.

Holotype.—Alate viviparous female; Metropolis, Illinois, April 17, 1930, on *Achillea Millefolium*, (Frison and Ross). Slide No. 10786. *Allotype.*—Alate male; Urbana, Illinois, October 7, 1929, on *Achillea Millefolium*, (Frison and Ross). Slide No. 10787. *Morphotype.*—Apterous viviparous female (virgogenia); same data as holotype. Slide No. 10788. *Morphotype.*—Apterous oviparous female; Urbana, Illinois, November 5, 1929, on *Achillea Millefolium*, (Frison and Ross). Slide No. 10789. *Paratypes.*—Eighty-three slides of alate and apterous viviparous females, pupae, and nymphs; all collected in Illinois, on *Achillea Millefolium*, as follows: Metropolis, April 17, 1930; Starved Rock State Park, May 13, 1930; and Urbana, September 3, October 6, 7, 15 and 16, and November 5, 1929. Collectors T. H. Frison, F. C. Hottes, and H. H. Ross. Slides Nos. 10790-10842 and others unnumbered.

The combination of structural characters of this new species is such that we know of no very closely allied species within the genus. It is most easily separated from all other described *Capitophorus* by virtue of its extremely short cornicles. According to our observations, this species is at times abundant locally, but it is difficult to locate because its general color agrees so well with that of its host plant. A plant of *Achillea* found in Starved Rock State Park was so heavily infested by this species that many of the leaves were turning brown.

CAPITOPHORUS POAE (GILLETTE)

Rhopalosiphum poae Gillette, Canadian Entomologist, Vol. XL, No. 2, February, 1908, p. 61.

This species has been recorded from Aurora, Illinois, by Davis (1911b) under the name of *Rhopalosiphum poae*. It was not found by us in our collecting during 1928 to 1930 and apparently is not very abundant. Gillette mentions that it is capable of killing blue grass. Only the viviparous females have thus far been described.

Data associated with slides deposited in the Survey collection through the kindness of Professor Davis are as follows: Aurora, Nov. 14, 1910, and Rockford, Nov. 12, 1912. All specimens taken on *Poa pratensis*.

CAPITOPHORUS RIBIS (LINNAEUS)

FIGS. 34, 167

Aphis ribis Linnaeus, Systema Naturae, Editio Decima, 1758, p. 451.

The currant aphid, which causes a characteristic distortion or "puffiness" and reddish discoloration of the leaves (Fig. 34), was first



Fig. 34. Malformation of leaves of the red currant, *Ribes vulgare*, caused by the currant aphid, *Capitophorus ribis* (Linnaeus); Champaign, June 14, 1929.

definitely recorded from Illinois by Davis (1910e). The fruit of badly infested currant bushes often ripens prematurely and is poor in quality because of the falling of infested leaves. According to Gillette and Bragg (1917), Theobald (1926), and others, the currant aphid usually migrates in summer from its over-wintering host to such plants as *Galeopsis*, *Stachys*, *Polygonum*, and *Leonurus*. All forms have been described by several authors, including Gillette and Bragg (1917) and Theobald (1926).

Data associated with our viviparous specimens are as follows: Normal (May 29), 1884; Champaign (May 18), French Grove (June 4-9), 1886; Champaign (June 19), LeRoy (June 19-20), 1928; Arcola (May 10), Champaign (May 22), Galena (July 10), Lawrenceville (June 18), Macomb (May 26), Monticello (May 24), Putnam (May 5), Rock Island (July 9), 1929; Grand Detour (May 16), Rock Island (June 3), 1930. All specimens taken upon *Ribes Grossularia*, *Ribes nigrum*, *Ribes odoratum*, and *Ribes* sp.

CAPITOPHORUS TETRARHODUS (WALKER)

Aphis tetrarhoda Walker, The Annals and Magazine of Natural History, Vol. IV, Second Series, London, 1849, p. 42.

This species has not previously been reported from Illinois, unless the records of Davis (1910e) under the name of *Myzus rosarum* Walker apply to it. Only the viviparous females have been described (Theobald, 1926), and very little is known concerning the biology of this plant louse. Specimens taken out of doors at Urbana in November failed to continue to reproduce parthenogenetically in the greenhouse. Two of our specimens are of special interest in that in one a cornicle is entirely lacking and in a second specimen a cornicle is very aberrant. Dr. Theobald has kindly checked our determination of this species. The sexual forms are described here for the first time.

Data associated with our viviparous specimens are as follows: Urbana (June 6), 1928; and Urbana (Nov. 19, 26), 1930. Sexual forms and eggs have been taken Nov. 19-26, 1930. All collected on *Rosa* sp.

APTEROUS MALE

Length from vertex to tip of anal plate, 1.10. Body dark grayish brown, with greenish bands extending between the segments across the dorsum of the abdomen, and with the venter almost entirely greenish. Antennae, legs except base of femora, external genitalia, cornicles, cauda, and anal plate, dark brown. Extreme base of third antennal segment, basal fourth of femora, and area around base of cornicles, pale yellowish. Middle portion of hind tibiae lighter brown than the remainder.

Width of head across eyes, .34. Head with about 16 capitate hairs. Antennae with scattered capitate hairs, the comparative lengths of the segments as follows: II— .43, IV— .19, V— .17, VI— .09 plus .23. Secondary sensoria present on the third and fifth segments, and occasionally on the fourth, as follows: III— 20 to 26, average 22; IV— 0 to 1; V— 4 to 8, average 6. Body with a row of capitate setae along each lateral margin. Abdomen with four longitudinal dorsal rows of setiferous tubercles arranged segmentally, two on each side of the meson, the two mesal tubercles each with two capitate setae on the middle segments, the two lateral tubercles each with one seta. This pattern is reduced on the thorax. Cornicles and cauda as in other forms, respectively .19 and .10 in length.

APTEROUS OVIPAROUS FEMALE.

Length from vertex to tip of anal plate, 1.37. Body yellowish green; flagella of antennae, apices of front and middle tibiae, hind tibiae except

extreme base, tarsi, cornicles, cauda, and anal plate yellowish brown; eyes black.

Body with numerous capitate hairs, arranged in two lateral and four dorsal series, but not on such distinct tuberculate areas as in the male. Width of head across eyes, .33. Comparative lengths of antennal segments as follows: III—.24, IV—.10, V—.14, VI—.09 plus .19. Secondary sensoria absent. Cornicles and cauda as in other forms, respectively .20 and .13 in length. Hind tibiae .61 in length, swollen before middle, with about 70 distinct sensoria.

Allotype.—Apterous male; Slide No. 9796, Urbana, Illinois, November 24, 1930, on *Rosa* sp., (T. H. Frison). *Morphotype*.—Apterous oviparous female; Slide No. 9795, Urbana, Illinois, November 19, 1930, on *Rosa* sp., (T. H. Frison). On slide with oviparous females and nymphs

GENUS IDIOPTERUS DAVIS

Key to the Species of the Genus Idiopterus

1. Cornicles cylindrical and tapering towards apex, with basal one-third dark and remainder light in color....*nephrelepidis* Davis p. 292
- . Cornicles slightly swollen, rather uniformly dark in color.....
..... *violae* (Pergande) p. 292

IDIOPTERUS NEPHRELEPIDIS DAVIS

FIGS. 58, 66

Idiopterus nephrelepidis Davis, Annals of the Entomological Society of America, Vol. II, No. 3, September, 1909, p. 199.

This species has not been taken in Illinois since it was originally described by Davis (1909c) from sword fern growing in a Chicago greenhouse. It is a species with beautifully marked wings and of special interest because of the variation exhibited in the radial and medial veins (Figs. 58, 66) of the fore wings. There is not much doubt that it is a species of tropical origin introduced into greenhouses. Besides the descriptions and illustrations of the viviparous females contained in the original description, there are articles by Essig (1911b), Baker (1919b), and Theobald (1926), which contain additional information and descriptive matter.

Data associated with the lectotypic slide (No. 3117) in the Survey collection are as follows: Chicago (May 2), 1908, on *Nephrelepis* sp., collected by J. J. Davis.

IDIOPTERUS VIOLAE (PERGANDE)

Rhopalosiphum violae Pergande, Canadian Entomologist, Vol. XXXII, No. 2, February, 1900, p. 29.

This species has been taken only once in Illinois, at Peoria, by Davis (1910e), who collected it on violets, its only known host. Besides the original description and a few records there is almost nothing in literature concerning this species. Baker (1919b) considers that *Neotoxoptera violae* Theobald (1915) from Africa is only an aberration of this species. As in *I. nephrelepidis* Davis, the radial and medial veins are variable and the wing veins are prominently outlined with

fuscous shading. The genera *Idiopterus*, *Microparsus*, and *Pentalonia* have been grouped together by several writers to form the subtribe Pentalonina.

Data associated with our viviparous specimens are as follows: Peoria (Sept. 24), 1910, on *Viola* sp., collected by J. J. Davis.

GENUS MACROSIPHUM PASSERINI

SUBGENERA MACROSIPHUM PASSERINI, CATAMERGUS OESTLUND, ILLINOIA WILSON, AND MACROSIPHONIELLA DEL GUERCIO

Key to the Species of the Genus Macrosiphum

1. Apex of cornicles with closed reticulations (Fig. 120).....7
- Apex of cornicles smooth or imbricated, never with closed reticulations (Fig. 118).....2
- 2 Secondary sensoria on third antennal segment very irregularly arranged, not in a straight row (Fig. 296).....4
- Secondary sensoria on third antennal segment essentially in a straight row (Fig. 293).....3
3. Cauda more than one-half length of cornicles...*pisi* (Kaltenbach) p. 317
- Cauda about one-third the length of cornicles...*schranksi* Theobald p. 326
4. Fourth antennal segment with from 8 to 20 secondary sensoria.....*purpurascens* (Oestlund) p. 318
- Fourth antennal segment never with more than four secondary sensoria.....5
5. Fourth, fifth, and sixth antennal segments black or dark brown.....6
- Fourth and fifth antennal segments yellowish at base, dusky at apex.....*ribiellum* Davis p. 319
6. Tibiae almost uniformly brown or black; apical third of cornicles often slightly swollen.....*crataegi* (Monell) p. 304
- Tibiae not uniformly brown or black, apex darker; cornicles never swollen.....*dirhodum* (Walker) p. 304
7. Secondary sensoria on third antennal segment approximately in a straight row (Fig. 293).....8
- Secondary sensoria on third antennal segment not approximately in a straight row (Fig. 294).....21
8. Cornicles much shorter than length of third antennal segment.....9
- Cornicles approximately equal to, or longer than, length of third antennal segment.....14
9. Cornicles approximately as long as, or longer than, width of head through eyes.....10
- Cornicles shorter than width of head through eyes.....*granarium* (Kirby) p. 308
10. Fourth antennal segment almost twice as long as width of head through eyes.....11
- Fourth antennal segment shorter, or but slightly longer, than width of head through eyes.....13
11. Third antennal segment distinctly imbricated; anal and cubital conspicuously outlined with fuscous border.....*carpinicolens* Patch p. 301
- Third antennal segment not distinctly imbricated.....12
12. Cornicles black except for extreme base; anal and cubital veins of fore wing strongly outlined with fuscous border; extreme apical reticulated portion of cornicle slightly constricted....*venaefuscae* Davis p. 332
- Cornicles with basal half pale and apical half fuscous; anal and cubital veins not outlined with fuscous border; extreme apical reticulated portion of cornicle not constricted....*pallens* n. sp. p. 315

13. Secondary sensoria on third antennal segment numbering from 15 to 20; femora essentially pale greenish; in life with abdomen pale greenish.....*adianthi* (Oestlund) p. 296
- Secondary sensoria on third antennal segment numbering from 5 to 10; femora with apical half dark brown or black; in life with abdomen with brownish markings on a ground color of ruby red or yellow.....*sanguinarium* n. sp. p. 323
14. Anal and cubital veins of fore wings strongly outlined with a fuscous border15
- Anal and cubital veins of fore wings not outlined with a fuscous border17
15. Abdomen surrounding base of cornicles greenish; cauda approximately half the length of cornicles.....16
- Abdomen surrounding base of cornicles blackish or brownish; cauda considerably less than one-third the length of cornicles*coryli* Davis p. 303
16. Hind tibiae about five times as long as width of head through eyes; on wild geranium.....*geranii* (Oestlund) p. 307
- Hind tibiae about four times as long as width of head through eyes; on basswood, or linden.....*tilliae* (Monell) p. 331
17. Length of cornicles at most equal to length of third antennal segment18
- Length of cornicles considerably longer than third antennal segment.....*laevigatae* Essig. p. 314
18. Fourth antennal segment as long as, or longer than, the third.....*tilliae* (Monell) p. 331
- Fourth antennal segment shorter than the third.....19
19. Cornicles almost uniformly cylindrical, not bulging before reticulations at apex (Fig. 111); abdomen in life usually greenish or pink; developing on a great variety of plants but not naturally on *Liriodendron*.....20
- Cornicles slightly bulging just before reticulations at apex (Fig. 110); abdomen in life usually yellowish green; developing on *Liriodendron**liriodendri* (Monell) p. 314
20. Cornicles a deep black, hind tibiae usually uniformly deep black*pseudorosae* Patch p. 318
- Cornicles pale to dusky, hind tibiae usually pale to dusky with apices darker and contrasting.....*gei* (Koch) p. 306
21. Cornicles much shorter than width of head through the eyes.....22
- Cornicles about equal to, or longer than, width of head through the eyes25
22. Fourth antennal segment with five or more secondary sensoria, body rather uniformly reddish brown in color.*sanborni* Gillette p. 323
- Fourth antennal segment usually without any secondary sensoria but sometimes with one or two; body not reddish brown.....23
23. Cauda short, somewhat triangular in shape, about as long as combined length of first and second antennal segments.....*kickapoo* n. sp. p. 312
- Cauda more elongate and tapering, much longer than combined length of first and second antennal segments.....24
24. Cornicles much shorter than width of head; secondary sensoria on fourth antennal segment rarely exceeding thirty-five in number; fourth antennal segment scarcely longer than width of head.....*frigidicola* (G. & P.) p. 305
- Cornicles but slightly shorter than width of head; secondary sensoria on fourth antennal segment usually more than forty in number; fourth antennal segment much longer than width of head*ludoviciana* (Oestlund) p. 315
25. Fourth antennal segment with secondary sensoria.....*sonchellum* (Monell) p. 326
- Fourth antennal segment without secondary sensoria.....26

26. On ferns; general body color green; third antennal segment with about fifty secondary sensoria, cauda very short..... *ptericolens* Patch p. 318
- Not frequenting ferns; general body of various colors including green; third antennal segment with various numbers of sensoria; cauda short to long.....27
27. Cornicles equal to or longer than third antennal segment.....28
- Cornicles shorter than third antennal segment.....31
28. Segment anterior to cornicles with a lateral tubercle.....
- Segment anterior to cornicles without a lateral tubercle..... *ruralis* n. sp. p. 321
29. Reticulated area of cornicles about equal to length of basal portion of sixth antennal segment (Fig. 108); base of cornicles surrounded with a blackish or brownish area.....
- Reticulated area of cornicles much longer than length of basal portion of sixth antennal segment (Fig. 120); base of cornicles not surrounded with a blackish or brownish area..... *rosae* (Linnaeus) p. 320
30. Third antennal segment with less than forty secondary sensoria; fourth antennal segment much shorter than third.....
- Third antennal segment with more than forty secondary sensoria; fourth and third antennal segments about equal in length..... *erigeronensis* (Thomas) p. 304
31. Third antennal segment longer than the metathoracic femora.....
- Third antennal segment shorter than the metathoracic femora..... *zinzalae* n. sp. p. 332
32. Fourth antennal segment averaging about as long or longer than third antennal segment.....
- Fourth antennal segment averaging much shorter than third antennal segment..... *gravicornis* Patch p. 308
33. Anal and cubital veins distinctly outlined with a border of fuscous; area of cornicles with closed reticulations about one-fifth of total length; cauda light green; cornicles without dark area surrounding base.....
- Anal and cubital veins not outlined with a border of fuscous; area of cornicles with closed reticulations about one-third of length; cauda dark brown or black; cornicles with dark area surrounding base..... *venaefuscae* Davis p. 332
34. Cornicles much shorter than length of fifth antennal segment; abdomen yellowish green or pea green, dark cornicles strongly contrasting with body, pulverulent in life.....
- Cornicles about as long as, or longer than, length of fifth antennal segment; abdomen greenish, brownish or reddish..... *illini* n. sp. p. 309
35. Abdomen dominantly colored some shade of green..... *ludoviciana* (Oestlund) p. 315
- Abdomen dominantly colored some shade of brown or red..... *tapuskae* n. sp. p. 327
36. Hind tibiae with basal one-fifth light brown, middle three-fifths yellowish or yellowish-green, and apical one-fifth dark brown or black.....
- Hind tibiae almost uniformly dark brown or black, or at least with basal third dark brown or black and middle third not strongly contrasting with base and apical thirds..... *pseudorosae* Patch p. 318
37. Third antennal segment seldom with more than 25 secondary sensoria, these sensoria rather narrowly scattered and not especially tuberculate (Fig. 297).....
- Third antennal segment seldom with less than 35 secondary sensoria, these sensoria widely scattered and very tuberculate (Fig. 308)..... *anomalae* n. sp. p. 298
38. Body of species essentially shades of red.....39
- Body of species essentially shades of brown.....40

39. Third antennal segment seldom with more than 25 secondary sensoria, these sensoria rather narrowly scattered and not prominently tuberculate (Fig. 297).....*pseudorosae* Patch p. 318
- Third antennal segment seldom with less than 35 secondary sensoria, these sensoria widely scattered and prominently tuberculate (Fig. 308).....*rudbeckiae* (Fitch) p. 320
40. Hind femora at most with basal one-third light colored and contrasting with remaining dark portion; hind tibiae uniformly dark colored; antennal segments, legs, head, and body with numerous stout spine-like setae, many of which may be capitate; about crown of dandelion.....*taraxaci* (Kaltenbach) p. 329
- Hind femora with basal half light colored and contrasting with dark apical half, rarely with proportions less; hind tibiae uniformly dark or with dark apical portion contrasting with basal or mesal portions; spine-like setae less numerous and more slender, sometimes capitate; on stems and leaves of upper parts of plants.....41
41. Color in life deep blackish red; cauda dark, about concolorous with abdomen; species apparently restricted to *Helenium*; coefficient A* averaging 4.5.....*tardae* n. sp. p. 329
- Color in life brownish; cauda light or yellowish in color; not restricted to *Helenium*; coefficient A averaging more than 5.0.....42
42. Restricted to *Impatiens*.....*impatiensicolens* Patch p. 312
- Common on a large number of plants, particularly Compositae.....43
43. Cornicles averaging shorter in length; coefficient A averaging slightly more than 5; most often taken on *Bidens*.....*chrysanthemi* (Oestlund) p. 302
- Cornicles averaging longer than the preceding; coefficient A averaging about 6; not yet recorded from *Bidens* but common on many plants.....*ambrosiae* (Thomas) p. 298

MACROSIPHUM ADIANTI (OESTLUND)

Siphonophora adianti Oestlund, Geological Survey of Minnesota, Fourteenth Report, 1886, p. 26.

This species, not previously reported from Illinois nor recorded since it was described from Minnesota, was abundant on the undersides of the divisions of the fronds of ferns of the genus *Aspidium* on side walls of the various canyons in Starved Rock State Park. Alate forms seem to be uncommon, and the two specimens secured by us were reared from pupae. Dr. Oestlund has confirmed our identification of this species and agreed that the statement concerning length of cornicles in the original description was in error.

In view of the fact that many details are omitted in the original description, a redescription is presented of the previously known apterous viviparous female. A description is given, also, of the alate form which had not been previously discovered.

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.41. Color of head light dusky yellow with brownish area around ocelli, color of thorax and abdomen pale yellowish green; cornicles and cauda concolorous with abdomen. First and second antennal segments concolorous with head, third brown with exception of extreme base which is light yellowish, remaining segments lighter in color. Femora pale yellowish green with the extreme apical portions fuscous; tibiae greenish with apical por-

* Coefficient A equals length of hind tibiae plus length of cornicle, divided by width of head.

tions fuscous; tarsi fuscous. Stigma smoke-colored; veins brown, anal and cubital veins darkest and bordered with brownish suffusions; posterior margin of wing in vicinity of anal vein brownish. Beak greenish yellow with the last two segments brownish.

Head and appendages.—Average width of head across eyes, .49. Antennal segments with the following comparative lengths: III— .71 to .74, average .72; IV— .39 to .44, average .41; V— .43; VI— .14 plus .91. Secondary sensoria (Fig. 293) with wide margins, confined to the third antennal segment, arranged in a straight row and numbering from 15 to 20, averaging 17. Beak reaching to mesothoracic pair of coxae. Width of head through eyes averaging .48.

Thorax and appendages.—Stigma of fore wings quite pointed. Second fork of media considerably closer to margin of wing than to the first fork, all veins failing to reach margin of wing.

Abdomen.—Cornicles (Fig. 101) .49 long, straight; apical area covered by closed reticulations equal to about one-fifth their length, remaining portion imbricated. Cauda (Fig. 165) .21 long, not constricted, with about four hairs on a side. Anal plate rounded.

Morphotype.—Alate viviparous female; Starved Rock State Park, Illinois, May 13, 1930, on fern, (Frison and Ross). Slide No. 10571.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.45. Entire body light yellowish-green. Anal plate concolorous with abdomen; cauda somewhat lighter in color than abdomen. Cornicles very light yellowish-green, almost white, at the base but somewhat fuscous at extreme apex. Beak yellowish-brown, the tip brownish. First and second antennal segments essentially concolorous with head, beginning with the third antennal segment and extending to apex of antennae gradually shading from dusky yellow to dark brown, the apices of third and fourth segments darker than rest of segments and contrasting. Coxae, trochanters, and basal portions of femora essentially concolorous with body; apical portion of femora and tibiae light yellowish-green but gradually becoming more and more brown until at apices of tibiae color is dark brown; tarsi dark brown.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with comparative lengths as follows: III— .59 to .64, average .61; IV— .30 to .36, average .34; V— .36 to .39, average .38; VI— .10 to .11, average .11 plus .71 to .83, average .79. Secondary sensoria limited to the third antennal segment, small, arranged in a straight row and limited to the basal half of the segment, number varying from 3 to 7 and averaging 5. Hair on the antennae exceedingly scarce, fine and short. Beak stout, reaching about to the coxae of the metathoracic legs.

Thorax and appendages.—The hairs on the basal portions of the tibiae are exceedingly fine and short; they increase in length toward the apex, where they are just slightly shorter than the width of the segment.

Abdomen.—Cornicles straight, comparatively short for a species of *Macrosiphum*, averaging about .45 in length; with from 3 to 5 indistinct rows of closed reticulations at the apex; flange at the apex poorly developed; imbrications present but exceedingly faint. The cauda averaging .16 in length, not constricted, stout, conical, with four hairs on a side; like the cornicles, it is short for a species of *Macrosiphum*. Anal plate as normal for the genus.

Data associated with our specimens are as follows: Starved Rock State Park (Aug. 14, Sept. 10), 1929, and (May 13), 1930.

This species is easily separated from the related *M. ptericolens* Patch (also found on ferns in Illinois) by the fact that the cornicles are only slightly fuscous at the apex, whereas in *ptericolens* they are very dark for most of their length; by the absence of a constriction of the cornicle before the apex; by its smaller size; and by the reduced number of the secondary sensoria.

MACROSIPHUM AMBROSIAE (THOMAS)

Siphonophora ambrosiae Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 4.

This common and widely distributed species in Illinois (Fig. 35) was described by Thomas (1877) from specimens collected at Sioux City, Iowa, but was not recorded by him from Illinois. The species is not listed by Davis (1911b), but his host records for *M. rudbeckiae* (Fitch) indicate it was included with the latter.

Cotypic specimens of this species were found among the Thomas material and mounted on slides. Slide No. 8179 has been selected as the *lectotypic* slide and Sildes Nos. 8180 and 8181 labeled as *paratypic* slides. All typic material is in poor condition but recognizable. Data associated with the typic slides are as follows: Sioux City, Iowa, September 3, 1877 (original description states September 1).

Illustrations are given of the cauda (Fig. 184), cornicle (Fig. 114), and third antennal segment (Fig. 302) of the alate viviparous female on the lectotypic slide and the third antennal segment (Fig. 301) of the apterous viviparous female on the same slide.

Data associated with our viviparous specimens are as follows: Carbonale (June 4), Champaign (July 9), Danville (June 15), Elizabethtown (Oct. 12), Havana (June 21), LeRoy (June 20), Mahomet (Oct. 2), Mattoon (June 10), Morton (July 22), Mt. Carroll (June 25), Muncie (Oct. 6), Oakwood (July 8, Sept. 17), Oregon (June 27), Quincy (June 6), Rock Island (June 24), Starved Rock State Park (June 12, 13), Urbana (July 10, Aug. 2, Sept. 10, Oct. 7, 22), 1928; Beach (Aug. 29), Cairo (June 22), Champaign (May 28), Choate (Sept. 28), Edwardsville (Sept. 11), Farmer City (Sept. 22), Grayville (June 19), Homer (June 19), Jonesboro (June 23), Mahomet (Aug. 17), Mitchell (June 25), Oakwood (Sept. 22, Oct. 13), Starved Rock State Park (Sept. 10), Urbana (Sept. 17, Oct. 28), 1929; Starved Rock State Park (May 13), 1930. Collected on *Achillea Millefolium*, *Actinomeris* sp., *Ambrosia trifida*, *Ambrosia* sp., *Aster* sp., *Cirsium* sp., *Eupatorium urticifolium*, *Helianthus* sp., *Lactuca* sp., *Oenothera biennis*, *Prenanthes alba*, *Prenanthes* sp., *Rudbeckia hirta*, *Solidago* sp., *Sonchus* sp., *Taraxacum officinale*, and *Xanthium canadense*. Sexual forms collected at Elizabethtown (Oct. 12), 1928, on *Xanthium canadense* and at Urbana (Oct. 28), 1929, on *Cirsium* sp.

MACROSIPHUM ANOMALAE new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.66. Head, with exception of areas around simple eyes which are brownish, light green; thorax and abdomen light green. Cauda concolorous with abdomen; cornicles concolorous with abdomen at base for a distance about equal to the length of the first antennal segment, remaining portion fuscous or often almost black. First and second antennal segments dusky brown; remaining segments dark brown except that the base of the third segment is yellowish for a distance equal to the length of the second segment, and that the apical half of the terminal filament is yellowish-white or at least lighter than the basal portion. Coxae, trochanters, and basal halves of femora essentially concolorous with body, remaining portion brownish, the brown most extensive on the dorsal portions; tibiae yellowish at extreme base, remaining portion almost if not entirely uniformly brown; tarsi brown. Stigma of fore wings only slightly clouded with fuscous, veins light brown in color and thin. Beak concolorous with body, except for the two terminal segments, which are brownish.

Head and appendages.—Average width of head across eyes, .49. Antennal segments with comparative lengths as follows: III— .60 to .91, average .75;



Fig. 35. *Macrosiphum ambrosiae* (Thomas) on flower stems of the dandelion, *Taraxacum officinale*; Urbana, July 23, 1929.

IV— .34 to .57, average .48; V— .31 to .59, average .45; VI— .11 to .17, average .14 plus .41 to .86, average .55. Secondary sensoria (Fig. 308) limited to the third antennal segment, varying from thirty-five to fifty-one, large, with wide veins, and although scattered are nevertheless most numerous on one side of the segment. Beak extends to the coxae of the third pair of legs or slightly beyond.

Thorax and appendages.—Stigma narrow and pointed at tip; second fork of media usually closer to the margin of the wing than it is to first fork. Hairs on the tibiae distinctly spine-like, numerous and lighter in color than the tibiae.

Abdomen.—Cornicles (Fig. 116) about four times the length of the base of the sixth antennal segment, averaging about .49, being about subequal to the fourth antennal segment, tapering slightly to the tip, with a very poorly developed flange, area covered with closed reticulations about equal to one-fifth the length of the cornicles. Cauda (Fig. 180) long in comparison to the length of the cornicles, extending approximately as far as the tips of the cornicles, slender, sharply pointed, and only moderately constricted, usually four hairs on a side.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.92. Head, thorax, and abdomen light green. First and second antennal segments concolorous with head, except that gibbous portion of first segment is often dusky brown; third segment concolorous with second up to where the secondary sensoria begin, then gradually blending to dusky brown at the apex; fourth and fifth segments varying from entirely brown to a condition with basal half yellowish and apical half brownish, sixth segment brownish with terminal filament lighter than basal portion. Femora as in the alate viviparous female with the exception that the brown is less extensive; tibiae as in the alate viviparous female or light yellowish at the base, quickly replaced by brown which in turn is replaced by yellowish beyond the middle and then by brown at the apex; tarsi brown. Beak, cauda, and cornicles colored as in the alate viviparous female.

Head and appendages.—Average width of head across eyes, .47. Antennal segments with comparative lengths as follows: III— .71 to .89, average .81; IV— .39 to .59, average .48; V— .34 to .54, average .44; VI— .11 to .19, average .14 plus .44 to .64, average .53. Secondary sensoria similar in structure and position to those of the alate viviparous female, numbering from 28 to 41 and averaging 35. Beak reaches to, or slightly beyond, the coxae of the third pair of legs.

Thorax and appendages.—Except for the lack of wings, similar to the alate viviparous female.

Abdomen.—Cornicles and cauda similar in shape to those of the alate viviparous female except that they are longer, cornicles averaging .58 and cauda .46, although retaining about the same relative proportions.

Holotype.—Alate viviparous female; Urbana, Illinois, August 29, 1929, on *Aster novae-angliae*, (H. H. Ross.) Slide No. 10242. *Morphotype.*—Apterous viviparous female; Urbana, Illinois, August 22, 1929, on *Aster novae-angliae*, (H. H. Ross). On slide with three other specimens of apterous viviparous females. Slide No. 10243. *Paratypes.*—Forty-nine slides of alate and apterous viviparous females, pupae and nymphs; all collected in Illinois by T. H. Frison, F. C. Hottes, H. H. Ross, and A. R. Park, on *Aster novae-angliae* and *Aster* sp. The localities and dates are as follows: Oregon (June 27), Pekin (June 20), and Urbana (July 30), 1928; Ogden (May 26), and Urbana (July 1, August 18 and 29), 1929. Slides Nos. 10244-10277 and others unnumbered.

This species is suggestive of *Macrosiphum erigeronensis* (Thomas), from which it may be distinguished by its comparatively shorter cornicle in relation to the third antennal segment, and by the reticulated area of the cornicle being considerably less in extent than the reticulated area of *erigeronensis*.

This new species congregates near the top of the flower stalks of its host plant in much the same manner as *erigeronensis*.

MACROSIPHUM CARPINICOLENS PATCH

Macrosiphum carpinicolens Patch, Maine Agricultural Experiment Station, Bull. 282, December, 1919, p. 209.

This species has never been reported from Illinois; in fact, we know of no records of its occurrence except from Maine. We have found it to be particularly partial to the young and tender shoots of its host, the blue beach. Our determination of the apterous viviparous female of this species has been verified by Dr. Patch, who compared our specimens with types.

Data associated with our viviparous specimens are as follows: Starved Rock State Park (July 6), 1929; Golconda (April 15) and Oakwood (May 9), 1930. Sexual forms taken at Oakwood (Oct. 17), 1929. All collected on *Carpinus caroliniana*.

This species was originally described by Dr. Patch from the apterous viviparous female only. We have included here the descriptions of several forms which to our knowledge have not before appeared in literature.

ALATE VIVIPAROUS FEMALE

Size and general color.—Length, 1.86. Head light brownish, thorax and abdomen pale greenish. Antennae black except first two segments and base of third, which are concolorous with head. Cornicles with basal one-fourth greenish, remaining portion black or dark brown with a greenish cast. Cauda and anal plate concolorous with abdomen. Femora yellowish green with apical portion dark brown; tibiae brown with apical portions almost black; tarsi black or very dark brown. Veins of wings, especially anal and cubital veins, deep brown bordered with brownish.

Head and appendages.—Average width of head across eyes, .51. Antennal segments with the following comparative lengths: III—1.04; IV—1.00; V—.86 VI—.23 plus 1.36. Secondary sensoria (Fig. 292) confined to third antennal segment, arranged in a straight row and numbering from 5 to 10; not extending beyond middle of segment. Third antennal segment with characteristic imbrications peculiar to species. Beak extending just beyond mesothoracic coxae.

Thorax and appendages.—Stigma and fore wings quite sharply pointed. Second fork of media variable in position, in one case lacking. All veins ending in brownish suffusions.

Abdomen.—Abdomen with a pair of small lateral tubercles just anterior to cornicles. Cornicles .86 long (Fig. 102), straight, a little more than apical sixth reticulated; remaining portions of cornicles imbricated. Apex of cornicle with a poorly developed flange. Cauda (Fig. 170) only slightly constricted and about .37 long, with three hairs on a side.

ALATE MALE

Size and general color.—Average length, 1.35. Color essentially the same as that of alate viviparous female. Genitalia brownish.

Head and appendages.—Average width of head across eyes, .49. Antennal segments with the following proportions: III—.90 to .97, average .93; IV—.93 to .96, average .95; V—.71 to .86, average .78; VI—.17 to .21, average .18 plus .64 to 1.36, average 1.10. Secondary sensoria usually confined to third and fifth antennal segments, one specimen with two sensoria on fourth. The absence of sensoria on the fourth antennal segment together with their presence on the fifth is very unusual but apparently constant. Sensoria on third antennal segment irregularly arranged although more abundant on

one side, numbering from 38 to 47, averaging about 40; sensoria on fifth segment numbering from 17 to 21, averaging about 19; all segments imbricated. Primary sensorium on sixth antennal segment with a group of about 6 marginal sensoria at one side. Wings similar to those of alate viviparous female. Cornicles averaging .47 in length, otherwise as in the alate viviparous female. Cauda averaging .17 long, not constricted, with about four hairs on a side.

APTEROUS OVIPAROUS FEMALE

Average length 1.97. Essentially the color as described for alate viviparous female. Average width of head across eyes .43. Comparative lengths of antennal segments as follows: III— .67 to .80, average .75; IV— .60 to .79, average .70; V— .57 to .66, average .63; VI— .19 to .21, average .20 plus .79 to 1.00, average .90. Third antennal segment with a single secondary sensorium near base. All segments imbricated. Cornicles .56 long. Cauda .21 long. Hind femora very much swollen and with about 300 sensoria.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Average length, 2.50. Color essentially as in alate viviparous female, except in life a much darker reddish green. Average width of head across eyes, .54. Antennal segments with the following comparative lengths: III— .69 to .81, average .75; IV— .57 to .59, average .58; V— .50 to .57, average .53; VI— .21 to .23, average .22 plus .64. Third antennal segment with a single sensorium near base, less imbricated than that of other forms. Beak reaching to middle of mesothoracic coxae. Prothorax with lateral tubercles, differing in this respect from the other forms. Cornicles .56 long; cauda (Fig. 166) .21 long. Otherwise as in alate viviparous female.

Morphotype.—Alate viviparous female; Slide No. 8900, Oakwood, Illinois, May 9, 1930, on *Carpinus caroliniana*, collected by T. H. Frison. On slide with nymphs. *Allotype*.—Alate male; Slide No. 8470, Oakwood, Illinois, October 17, 1929, on *Carpinus caroliniana*, collected by Frison and Ross. *Morphotype*.—Apterous oviparous female; Slide No. 8474, same data as allotype. On slide with oviparous females. *Morphotype*.—Apterous viviparous female (fundatrix); Slide No. 8899, Golconda, Illinois, April 15, 1930, on *Carpinus caroliniana*, collected by Frison and Ross.

MACROSIPHUM CHRYSANTHEMI (OESTLUND)

Siphonophora chrysanthemi Oestlund, Fourteenth Annual Report of the Geological and Natural History Survey of Minnesota, 1886, p. 22.

This species has not been reported previously from Illinois. Our determination of it has been verified by Dr. Oestlund. Soliman (1927) has given technical descriptions of the viviparous forms. It is very closely allied to *M. ambrosiae* (Thomas), and future biological studies may prove them to be forms or varieties of the same species. The sexual forms considered by us as this species, however, appear to differ from sexual forms of *ambrosiae* in having fewer secondary sensoria. Descriptions of the alate male and the apterous oviparous female of this species are given here since they have not been described elsewhere.

Data associated with our viviparous specimens are as follows: Elizabethtown (Oct. 12), 1928; Decatur (Sept. 21, Oct. 19), Jonesboro (Sept. 28), Kappa (Sept. 9), Mahomet (Sept. 4), Mt. Vernon (Sept. 27), Oakwood (Oct. 13), 1929. Sexual forms have been collected as follows: Elizabethtown (Oct. 12), Mahomet (Oct. 6), 1928; Decatur (Oct. 19), Oakwood (Oct. 13), and Urbana (Oct. 24), 1929. Both viviparous and sexual forms collected on *Bidens* sp., *Bidens vulgata*, *Eupatorium urticacfolium*, *Prenanthes alba*, and *Solidago* sp.

ALATE MALE

Size and general color.—Average length, 1.91. Head and thorax rather dark dusky brown, thorax with a greenish cast. Abdomen greenish with lateral brownish spots on dorsum and similar spots posterior to the cornicles. Cornicles dark brownish black, cauda varying from greenish to dusky. Antennae light brownish green to dark brownish black. Genitalia dark blackish brown. Coxae, trochanters, and base of femora light yellowish; remainder of legs uniformly dark brown. Beak dusky brown with yellowish markings between segments. Stigma smoke-colored; veins light brown.

Structure.—Average width of head across eyes, .56. Comparative lengths of antennal segments as follows: III— .79 to 1.00, average .86; IV— .64 to .94, average .77; V— .53 to .77, average .67; VI— .11 to .17, average .15 plus .66 to 1.31, average 1.03. Secondary sensoria present on third, fourth, and fifth antennal segments, irregularly arranged on the third and in a more or less regular row on the fourth and fifth; average numbers as follows: III— 45; IV— 9; V— 10. Primary sensorium on sixth antennal segment with about six marginal sensoria at one side. Beak reaching to base of metathoracic coxae. Cornicles .49 long, straight; apical one-third with closed reticulations. Cauda .25 long, only slightly if at all constricted, with from 5 to 7 hairs on a side.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 2.22. Color of head, thorax, and abdomen greenish or yellowish brown. Cornicles dark brown; cauda yellowish green to light brownish. Antennae brownish except for yellowish base of third segment. Legs yellowish except for apical portions of femora, tibiae, and tarsi, which are dark brown. Average width of head across eyes, .53. Comparative lengths of antennal segments as follows: III— .64 to .74, average .69; IV— .41 to .54, average .49; V— .41 to .50, average .46; VI— .09 to .17, average .13 plus .61 to .86, average .75. Secondary sensoria confined to third antennal segment, irregularly arranged, restricted to one side of segment, usually not extending beyond basal half of segment, varying in number from 7 to 13 and averaging 10. Beak reaching to mesothoracic coxae. Cornicles .56 long, with slightly less than one-third of the apical portion reticulated. Cauda .33 long, not constricted, with from 6 to 7 hairs on a side. Hind tibiae very much swollen, with about 100 sensoria.

Allotype.—Alate male; Slide No. 8575, Oakwood, Illinois, October 13, 1929, on *Bidens* sp., (T. H. Frison). On slide with alate viviparous female. *Morphotype.*—Apterous oviparous female; Slide No. 7719, Elizabethtown, Illinois, October 12, 1928, on *Bidens* sp., (Frison and Hottes). On slide with apterous oviparous females.

MACROSIPHUM CORYLI DAVIS

Macrosiphum coryli Davis, Canadian Entomologist, Vol. XLVI, February, 1914, p. 48.

Specimens from Chicago, Illinois, formed part of the material from which this species was originally described. This species, according to our observations, is partial to the more tender terminal leaves and shoots of hazelnut growing in somewhat shaded situations. It is rather solitary in habit and is not as gregarious as many species of the genus. Technical descriptions of the viviparous forms only are given by Davis.

Data associated with viviparous specimens in our collection are as follows: Carbondale (June 4), Havana (June 20), Morton (July 22), Urbana (July 10), 1928; El Paso (July 5), Hardin (June 25), Herod (June 21), Kappa (Aug. 14), Rock Island (July 7), Starved Rock State Park (Sept. 10), 1929. All collected on *Corylus americana*.

MACROSIPHUM CRATAEGI (MONELL)

Siphonophora crataegi Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 20.

This comparatively rare species, often somewhat difficult to place generically because of slightly swollen cornicles suggestive of *Amphorophora*, was first recorded from Illinois by Davis (1911b). It feeds in small numbers upon the undersides of the leaves of *Crataegus* and apparently is never abundant enough to cause damage and attract attention. Davis (1911b) has recorded it from Chicago and figured the antenna of the wingless viviparous female. Patch (1914b) has described the alate viviparous female. A description of the apterous oviparous female is appended because this sexual form has not been recorded or described previously.

Data associated with our series of viviparous specimens are as follows: Bloomington (Aug 12), 1884; Oakwood (Sept. 17), Urbana (July 10), 1928; Highland Park (July 13), 1929. An oviparous female was taken at Urbana, Oct. 11, 1929. All collected on *Crataegus* sp.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of anal plate, 1.86. Color essentially similar to that of apterous viviparous female. Average width of head across eyes, .43. Comparative lengths of antennal segments as follows: III— .60, IV— .50, V— .46, VI— .13 plus .59. Secondary sensoria absent, segments feebly imbricated. Beak reaching to about mesothoracic coxae. Width of head through eyes, .43. Cornicles .57 long, with the apical half slightly swollen; flange at apex present. Cauda .21 long, not constricted, with two hairs on a side. Posterior tibiae with basal halves very much swollen and with about 150 sensoria, which extend beyond the swollen portion of the tibiae.

Morphotype.—Apterous oviparous female; Slide No. 8517, Urbana, Illinois, October 11, 1929, on *Crataegus* sp. (Frison and Ross).

MACROSIPHUM DIRHODUM (WALKER)

Aphis dirhodum Walker, Annals and Magazine of Natural History, Vol. III, 1849, p. 42.

This species has not been reported previously from Illinois. Our specimens agree well with the description as published by Theobald (1926). All forms have been described. It over-winters on rose and migrates to wheat, oats, and various other grasses for the summer months.

Alate viviparous specimens taken at Urbana (Oct. 21, Nov. 5), 1929, and males at Urbana (Nov. 5), 1929. All collected on cultivated *Rosa* sp.

MACROSIPHUM ERIGERONENSIS (THOMAS)

Siphonophora erigeronensis Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 7.

Specimens from Carbondale, Illinois, provided the material from which this species was described. It is quite common in the state and is found on the flower stalks and upper parts of the stems of its hosts. The descriptions of the alate male and the apterous oviparous female, both previously undescribed, are given here.

Slide No. 5157 in the Survey collection has been selected as the *neotypic* slide since the types of this species have not been recovered. Data associated with this slide are as follows: Carbondale, Illinois, June 4, 1928, on *Erigeron* sp., collected by Frison and Hottes.

Data associated with our viviparous specimens are as follows: Cairo (June 3), Carbondale (June 4), Champaign (July 18), Elizabethtown (May 29), Herod (May 29), Marshall (May 25), Metropolis (June 1), Mt. Carmel (May 26), Muncie (Oct. 6), Oregon (June 28), Starved Rock State Park (June 12), St. Joseph (Aug. 5), Urbana (Aug. 27), 1928; Decatur (June 12), Granite City (June 25), Kankakee (July 14), Kansas (June 17), Mahomet (Aug. 17), Oregon (July 11), Rock Island (July 7), Starved Rock State Park (July 5, 6, Aug. 14, Sept. 10), Urbana (Oct. 14), 1929; Urbana (May 19), 1930. Males and oviparous females were collected at Urbana (Oct. 14), 1929. All collected on *Aster* sp., *Erigeron annuus*, *Erigeron canadensis*, *Erigeron philadelphicus*, *Erigeron* sp., *Solidago canadensis*, and *Solidago* sp.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.27. Head and thorax very dark greenish brown; abdomen green with cornicles, cauda, anal plate, and genitalia dark brown. Antennae dark brown with the first and second segments and extreme base of third segment light greenish brown. Femora with basal third yellowish green, remaining portion dark brown; tibiae brown and darkest at apices; tarsi the same. Stigma brownish with posterior margin darkest. Veins brown bordered with very light brownish suffusions. Beak dusky green with two apical segments brownish.

Structure.—Average width of head across eyes, .41. Antennal segments with the following proportional lengths: III— .57 to .74, average .64; IV— .40 to .57, average .47; V— .37 to .50, average .44; VI— .11 to .16, average .14 plus .59 to .71, average .65. Secondary sensoria present on third, fourth, and fifth antennal segments, irregularly arranged, on fifth segment inclined to be present on apical half of segment, distributed as follows: III— 31 to 45, average 41, IV— 8 to 38, average 21, V— 12 to 13. Primary sensorium on sixth antennal segment with about six marginal sensoria. Cornicles .32 long, apical one-third covered with closed reticulations, remaining portion imbricated, flange at apex poorly developed. Cauda .21 long.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of anal plate, 2.14. Color essentially as in apterous viviparous female. Average width of head across eyes, .46. Comparative lengths of antennal segments as follows: III— .69 to .74, average .71; IV— .40 to .43, average .42; V— .37 to .41, average .39; VI— .13 to .14, average .14 plus .57. Secondary sensoria (Fig. 296) confined to third antennal segment and rarely extending beyond basal half of segment; irregularly arranged but confined largely to one side of the segment, averaging 13, greatest variation from average being 4. Beak reaching metathoracic coxae. Cornicles .87 long, apex covered with closed reticulations for a little more than one-fourth the length of the cornicles, remaining portion faintly imbricated. Cauda .36 long, scarcely constricted, with about five hairs on a side. Hind tibiae swollen above apical half, with about 60 sensoria.

Allotype.—Alate male; Slide No. 8488, Urbana, Illinois, October 14, 1929, on *Erigeron* sp., (Frison and Park). On slide with males. *Morphotype.*—Apterous oviparous female; Slide No. 8493, same data as allotype. On slide with oviparous females.

MACROSIPHUM FRIGIDICOLA (GILLETTE AND PALMER)

Macrosiphoniella frigidicola Gillette and Palmer, Annals of the Entomological Society of America, Vol. XXI, No. 1, March, 1928, p. 3.

This is the first published record of this species since it was described, and the first record of it outside of Colorado. Because of its

protective coloration it is very difficult to locate on its hosts. All forms of this species were included in the original description. Specimens of our material have been compared with paratypic material by Professor Palmer and found to be identical.

Data associated with our viviparous specimens are as follows: Urbana (Aug. 20, 25, Oct. 6, 7), 1929. All collected on *Achillea Millefolium*, *Artemisia abrotanum*, and *Artemisia pedemontana*.

MACROSIPHUM GEI (Koch)

Siphonophora gei Koch, Die Pflanzenlause Aphiden, 1857, p. 171, no. 16.

Siphonophora euphorbiae Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 6. *New synonymy*.

Siphonophora euphorbicola Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. I, No. 2, June, 1878, p. 6. *New synonymy*.

Hundreds of bulletins and short articles have been written concerning this cosmopolitan plant louse because of its economic importance as an enemy of the potato and spinach crops and the rôle it plays in the transmission of plant diseases. It has attracted the attention of the geneticists because of the existence of both pink and green forms or varieties. Patch (1915c) and Shull (1925) have shown that parthenogenetic females of each variety produce offspring which remain in color true to the stock from which they came. This extensive literature, most of which has been associated with the name of *M. solanifolii* (Ashmead), can not be reviewed here. First definitely recorded from Illinois by Davis (1911b) the name of *M. asclepiadis* Cowen. We do not believe that *curcubitae* (Thomas), the types of which are lost, is a valid species. It probably is a synonym of *M. gei*.

The rose is evidently the favorite winter or primary host of this species, but it is known to over-winter on a few other plants. Summer generations are found on a large number of hosts. Good descriptions of all forms are given by Patch (1911a and 1915c), Smith (1919), and Theobald (1926).

Cotypes of *Siphonophora euphorbiae* Thomas and *Siphonophora euphorbicola* Thomas have been recovered. Although this cotypic material is in very poor condition, there is no doubt that the specimens involved are identical with *M. gei*. Slide No. 8771 is a cotypic slide of *euphorbiae* Thomas and Slides Nos. 8772-8773 are cotypic slides of *euphorbicola*; all in the Survey collection.

Data associated with our viviparous specimens are as follows: Carbondale (June 4), Catlin (Sept. 27), Elizabethtown (May 31, Oct. 12, 22), Galena (June 25, 27), Havana (June 20, 22), Mahomet (Oct. 6), Metropolis (June 1), Mounds (June 2), Mt. Carmel (May 26), Oakwood (Sept. 17), Oregon (June 28), Paris (Nov. 28), Quincy (June 6), Shawneetown (May 27), St. Joseph (Aug. 5), Urbana (May 26, 28, 31, June 6, July 10, Aug. 6), 1928; Cairo (June 22), Carbondale (Sept. 28), Centralia (Sept. 26, 28), Collinsville (Sept. 11), Decatur (June 12), Edwardsville (Sept. 11), Evanston (Oct. 3), Jerseyville (June 25), Mahomet (Sept. 26), Makanda (Sept. 28), Monticello (Oct. 1), Mt. Vernon (Sept. 28), Normal (Aug. 14), Oakwood (Oct. 17), Rock Island (July 7, 9), Seymour (June 13), Urbana (Sept. 25, Oct. 7, 9, 15, 17), 1929; Golconda (April 15), Metropolis (April 17), Olive Branch (April 19), Urbana (Aug. 18), 1930. Specimens collected on *Amaranthus paniculatus*, *Amaranthus retroflexus*, *Amaranthus* sp., *Anthemis cotula*, *Apium* sp., *Apocynum* sp., *Artemisia* sp., *Asclepias* sp., *Calendula* sp., *Capsicum dulce*, *Chenopodium* sp., *Convolvulus* sp., *Cryptotaenia*

canadensis, *Cucurbita maxima*, *Eupatorium urticaefolium*, *Euphorbia marginata*, *Euphorbia* sp., *Helianthus* sp., *Ipomoea Batatas*, *Lactuca* sp., *Lagenaria vulgaris*, *Lathyrus* sp., *Ligustrum vulgare*, *Ligustrum* sp., *Lycopersicon esculentum*, *Pastinaca sativa*, *Pentstemon* sp., *Pisum sativum*, *Polygonatum* sp., *Polygonum Muhlenbergii*, *Polygonum* sp., *Polymnia* sp., *Rosa* sp., *Rumex* sp., *Saxifraga splendens*, *Scrophularia leporella*, *Senecio vulgaris*, *Solanum melongena*, *Solanum tuberosum*, *Spinacea olivacea*, *Trifolium repens*, and *Ulmus fulva*. Sexual forms taken in 1929 at Urbana (Oct. 17), on *Iris* sp., and at Oakwood (Oct. 17), on *Scrophularia* sp.

MACROSIPHUM GERANII (OESTLUND)

Nectarophora geranii Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 80.

This species has not been reported previously from Illinois. It occurs on the stems and undersides of the leaves of wild geranium. Specimens of our material were compared by Professor Oestlund with specimens considered by him as this species (the actual types are lost). The sexual forms are unknown. It is closely related to *M. gei* (Koch) but may be readily separated because of the heavily shaded anal and cubital veins of the fore wings. The descriptions of the alate viviparous female and the stem mother, never having been published, are added here.

Data associated with our viviparous specimens are as follows: Starved Rock State Park (June 13), 1928; Golconda (April 15), 1930. All collected on *Geranium maculatum*, or *Geranium* sp.

ALATE VIVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 2.23. Head and extreme base of third antennal segment yellowish green; mesothorax yellowish, shaded lightly with brown; prothorax, metathorax, abdomen, anal plate, and basal half of cauda apple green; apical half of cauda yellowish green. First and second antennal segments yellowish brown; flagellum except extreme base dark brown. Cornicles black. Coxae and trochanters greenish white; femora greenish white, with apical fifth dark brown; tibiae and tarsi dark brown. Beak concolorous with head, tip brown. Wings hyaline, stigma and costa whitish yellow, veins black, cubital and anal veins margined with fuscous. Eyes brownish.

Width of head across eyes, .56. Comparative antennal lengths as follows: III—.79 to .89, average .84; IV—.71 to .79, average .74; V—.67 to .74, average .71; VI—.16 to .20, average .18 plus .93 to 1.11, average 1.01. Secondary sensoria restricted to third antennal segment, numbering 5 to 8, average 6, arranged in a straight row and confined to basal half of segment. Flagellum beyond sensoria distinctly imbricated, entire antennae with scattered, weak setae. Cornicles .85 in length, slightly sinuate, with a distinct flange at apex, the apical fifth with large, closed reticulations, the remainder moderately imbricate. Cauda .37 in length, constricted at middle, basal half subconical, apex portion narrow, but with extreme tip rounded.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Length from vertex to tip of anal plate, 2.81. Head, thorax and abdomen a uniform shiny green (pea-green). Cauda and anal plate concolorous with abdomen. Eyes black. Cornicles at immediate base greenish, remainder black. Coxae, trochanters, and most of femora greenish; femora near apices slightly brownish; tibiae pale brownish green with black at apices for a distance about equal the tarsi; tarsi black. First and second antennal segments concolorous with head, third antennal segment light brownish but approaching black at tip; remainder of flagellum dark brownish or black. Beak concolorous with head at base, gradually becoming darker, and tip blackish.

Nymphs.—About as stem mothers except not a shiny green, but a soft, more pruinose green.

Width of head across eyes, .56. Average antennal lengths as follows: III— .91; IV— .62; V— .60; VI— .18 plus .83. Secondary sensoria usually absent, sometimes one present near base of third antennal segment. Third segment smooth, not imbricated, remainder of flagellum imbricated. Cornicles and cauda as in alate viviparous female, respectively .95 and .42 in length, the cauda less inclined to be constricted near middle.

Morphotype.—Alate viviparous female; Slide No. 9014, Golconda, Illinois, April 15, 1930, on *Geranium maculatum*, (Frison and Ross). *Morphotype*.—Apterous viviparous female (fundatrix); Slide No. 9019, same data as above. On slide with nymphs.

MACROSIPHUM GRANARIUM (KIRBY)

Aphis granaria Kirby, Transactions of the Linnean Society of London, 1798, Vol. IV, p. 238.

The English grain aphid is a widely distributed and common plant louse in Illinois (Fig. 16) and sometimes becomes a serious pest of cereals. It was first reported from the state by Thomas who mentions that it did considerable damage in 1866. In Illinois this aphid overwinters both in the egg stage and as viviparous females on grasses and autumn-sown cereals. Both green and pink forms are found, the pink ones being mainly responsible for the production of the sexual forms.

The literature of economic entomology contains many articles concerning the habits of this plant louse. Good technical descriptions of all forms may be found in the publications of Phillips (1916) and Theobald (1926). Records of *cerealis* (Kaltenbach) from Illinois by Pergande (1904) refer to this species.

Data associated with our viviparous specimens are as follows: DuQuoin (Sept. 7), Normal (June 19), 1883; Carmi (May 30), McHenry (July 31), Urbana (June 19), 1884; Urbana (May 21), 1885; Urbana (June 25), 1889; Roodhouse (July 16), 1891; Champaign (July 21), 1894; Beech Ridge (May 22), Lewistown (June 26, 28), 1907; Bloomington (July 5), Carbondale (June 21), Farmer City (July 5), Galena (July 10), Grayville (June 19), Herod (June 21), Homer (June 17), Jonesboro (June 23), Kankakee (July 14), LaSalle (July 5), Lawrenceville (June 18), Newton (June 17), Olney (June 18, 19), Oregon (July 11), Rock Island (July 7), Seymour (June 13), Sparta (June 24), Starved Rock State Park (July 6), Ullin (June 21), 1929; Gray's Lake (June 21), 1930. All collected on *Avena sativa*, *Trifolium pratense*, *Triticum aestivum*, and *Zea Mays*.

MACROSIPHUM GRAVICORNIS PATCH

Macrosiphum gravicornis Patch, Maine Agricultural Experiment Station, Bulletin 282, December, 1919, p. 213.

This species has not previously been reported from Illinois. It has similar habits and hosts to the allied species *M. crigeronensis* (Thomas), from which it is easily separated because of differences in comparative antennal lengths. Dr. Patch, who described the viviparous and oviparous females, kindly checked the determinations of some of our specimens. A description of the previously unknown male is presented here.

Data associated with our viviparous specimens are as follows: Galena (June 25, 27), Havana (June 21), Herod (May 29), Kankakee (June 29), Metropolis (May 31), Mt. Carroll (June 25), Oakwood (Sept. 17), Oregon

(June 27, 28), Pekin (June 20), Quincy (June 6), Rock Island (June 24), Starved Rock State Park (June 12), 1928; Beach (Aug. 29), Edwardsville (Sept. 11), Elizabethtown (June 20), Urbana (May 22), 1929. Specimens collected on *Aster* sp., *Erigeron philadelphicus*, *Erigeron* sp., *Lactuca*, sp., *Solidago canadensis*, and *Solidago* sp. Sexual forms taken on *Solidago* sp. at Oakwood, Oct. 17, 1929.

ALATE MALE

Average length from vertex to tip of anal plate, 1.20. General color as in alate viviparous female. Genitalia dark brown. Average width of head across eyes, .43. Comparative lengths of antennal segments as follows: III— .64 to .83, average .72; IV— .36 to .50, average .45; V— .36 to .50, average .43; VI— .11 to .14, average .12 plus .67 to .90, average .77. Secondary sensoria distributed as follows: III— 56 to 59, average 57; IV— 9 to 15, average 11; V— 4 to 12, average 7; sensoria on third segment somewhat tuberculate, covering most of segment, those on fourth and fifth segments usually in a more or less regular row, those of fifth segment usually nearer apical portion of segment. Beak reaching to, or sometimes beyond, middle of mesothoracic coxae. Cornicles .37 long, with about the apical third reticulated, remaining portion slightly imbricated. Cauda .20 long, constricted near middle, and with about 4 hairs on a side.

Allotype.—Alate male; Oakwood, Illinois, October 17, 1929, on *Solidago* sp., (Frison and Ross). On Slide No. 8733 with another male.

MACROSIPHUM ILLINI new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.27. Head and thorax chestnut brown blending to yellowish-brown at lateral margins. Abdomen lemon-yellow on dorsum with brownish patches on lateral margins; cauda and cornicles dark brown to almost black; area immediately around base of cornicles yellowish, but this area is surrounded by a brownish area much larger than patches on sides of abdomen anterior to cornicles. First antennal segment concolorous with the head, second segment somewhat lighter than the first, third segment concolorous with second for about length of second segment at base and then becoming dark brown or black, remaining segments mostly shades of brown with basal portions of segments lightest, particularly basal portion of fourth segment. Basal portions of femora light yellowish and the apical portion dark brown; tibiae mostly yellowish except for trace of brown near articulation with femora and a brown area at apex about three times the length of the tarsi; tarsi dark brown. Wings with veins light yellowish brown, the stigma of fore wings dark brown. Beak with basal portion concolorous with head and apical half dark brown.

Head and appendages.—Average width of head across eyes, .54. Antennal segments with comparative lengths as follows: III— .93 to 1.03, average .99; IV— .87 to 1.04, average .98; V— .84 to 1.00, average .93; VI— .17 to .24, average .21 plus 1.29 to 1.86, average 1.71. Secondary sensoria limited to the third antennal segment (Fig. 300); while scattered, they are confined largely to the basal half and one side of this segment; in number they range from 24 to 32. The beak extends to the coxae of the third pair of legs.

Thorax and appendages.—Stigma of fore wings sharply pointed; second fork of media of fore wing is closer to the margin of wing than to first fork; veins delicate.

Abdomen.—Four pairs of poorly developed lateral tubercles situated in center of lateral brownish areas, no lateral tubercles posterior to the cornicles. The cornicles (Fig. 103) are a little more than two times the length of the cauda and are reticulated at apex for one-third of their length; cornicles neither swollen or constricted; the length varies from .31 to .43 and averages .36. The cauda (Fig. 171) is comparatively short for the size of this aphid and about three times the length of the second segment of the hind tarsus; its sides are straight, without any constriction, and with five to six hairs on a side; their length varies from .75 to .93 and averages .82. Anal plate but little wider than the base of cauda.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.70. Pure lemon-yellow in color except the following which are brownish or blackish: apices of femora and tibiae, tarsi, tip of beak, area on third segment where secondary sensoria are concentrated, remainder of antennae beginning near middle of fourth segment, cornicles, area on abdomen surrounding and near base of cornicles, and cauda.

Head and appendages.—Average width of head across eyes, .55. Antennal segments with comparative lengths as follows: III— .97 to 1.42, average 1.05; IV— .86 to 1.04, average .96; V— .86 to .97, average .93; VI— .20 to .24, average .21 plus 1.79 to 1.00, average 1.47. The small secondary sensoria (Fig. 277) are restricted to the third segment and are concentrated in a small area removed from the base of the segment by a distance which is much less than one-half the length of the segment; the area free from sensoria occupies approximately the apical half of the segment. The beak extends to the coxae of the third pair of legs.

Abdomen.—Apparently without lateral tubercles and lateral brownish patches lacking except for large ones around base of cornicles. Cornicles, cauda and anal plate as in the alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 3.00. General color characters of the body similar to those of the apterous viviparous female.

Head and appendages.—Average width of head across eyes, .53. Antennal segments with comparative lengths as follows: III— .94 to 1.00, average .97; IV— .83 to .83, average .83; V— .84 to .86, average .85; VI— .15 to .15, average .15 plus 1.43. Secondary sensoria on third antennal segment as in the apterous viviparous female.

Thorax and appendages.—Similar to apterous viviparous female except that hind tibiae, partly basal half, are considerably swollen and thickly covered with sensoria (Fig. 303).

Abdomen.—Abdomen and structures found on abdomen as in apterous viviparous female.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.43. Head, thorax, abdomen, cornicles, cauda, and legs colored as in the alate viviparous female. The antennae differ in that they are almost entirely dark excepting base of third segment, which is somewhat yellowish for a distance equal to the width of the second segment at its base.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III— .87 to .93, average .89; IV— .89 to .93, average .91; V— .81 to .91, average .87; VI— .16 to .17, average .17 plus .96 to 1.64, average 1.33. The secondary sensoria (Fig. 285) are arranged as follows: III— 28 to 43, average 35; IV— 18 to 29, average 23; V— 10 to 19, average 14. The secondary sensoria are quite widely scattered over the surface of the third segment; on the fourth they are not confined to a row but are more numerous on one side of the segment than the other and show a slight tendency to favor the apical two-thirds of the segment; on the fifth segment they are arranged in a slightly irregular row. The beak reaches almost to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Thorax and appendages similar to those of the alate viviparous female.

Abdomen.—Abdomen with lateral tubercles as in the alate viviparous female. Cornicles twice the length of cauda and about one-half the length of third antennal segment, closed reticulations covering a distance equal to about one-third of the length of the cornicle. Cauda dusky brown.

Holotype.—Alate viviparous female; Jonesboro, Illinois, June 23, 1929, on *Helianthus* sp., (Frison and Hottes). Slide No. 10121. *Allotype.*—Alate male, Decatur, Illinois, October 5, 1929, on *Helianthus* sp., (Hottes). Slide No. 10122. *Morphotype.*—Apterous viviparous female; Urbana, Illinois, August 25, 1929, on *Helianthus* sp., (Frison and Hottes). Slide No. 10123.

Morphotype.—Apterous oviparous female; Herod, Illinois, October 12, 1929, on *Helianthus* sp., (Frison and Hottes). Slide No. 10124. *Paratypes*.—One hundred and two slides of males, oviparous females, apterous and alate viviparous females, pupae and nymphs; all collected in Illinois by T. H. Frison, F. C. Hottes, and H. H. Ross from species of wild or cultivated *Helianthus*. The localities and dates are as follows: Herod (October 12), 1928; Decatur (September 21 and October 5), Edwardsville (September 11), Hardin (June 25), Herod (June 29), Jonesboro (June 23), Metropolis (September 28), Nameoki (June 25), Oakwood (July 22 and October 13), Oregon (July 11), Rock Island (July 7), Savanna (July 9), Starved Rock State Park (July 6), St. Joseph (August 27), Urbana (October 7 and 9), 1929. Slides Nos. 10125-10193 and others unnumbered. Also two paratypic slides from Washington, D. C., on *Helianthus tuberosa*, and Lafayette, Indiana, Sept. 19, 1915, on sunflower, (J. J. Davis).

This handsomely colored species was first found at Herod, Illinois, on October 12, 1928. It was again found there the following year and subsequent collecting has shown it to occur in all parts of the state on wild *Helianthus* sp. It is evident from our experience with this species that it almost always frequents the undersides of the lowermost and larger leaves of its host, this habit perhaps being responsible for its escaping the notice of previous investigators. Although individuals of this species are not solitary in habit, we have never found them forming colonies of individuals as large as those formed by the closely related species of *M. ambrosiae* (Thomas) and *M. rudbeckiae* (Fitch). Our collecting is sufficient, too, to demonstrate that this new species in Illinois does not have such cosmopolitan tastes as *ambrosiae* and *rudbeckiae*, and as far as we have been able to discover, it is restricted to wild or cultivated species of *Helianthus*. The difference in the color of the cauda will separate *illini* from *ambrosiae* and *rudbeckiae*; in *illini* the cauda is dark brown or black, whereas in *ambrosiae* and *rudbeckiae* it is yellowish or pale and never dark or black.

The general outlines of the life history of this species conform to those of other species of the genus *Macrosiphum* in Illinois. The alate and apterous viviparous females, nymphs, and pupae were collected during June, July, August, September, and October. The sexual forms, males and oviparous females, have been found in October only and mating pairs were collected at Oakwood on October 13, 1929.

This species is named in honor of the past and present students of the University of Illinois, collectively referred to as the "Illini." The name itself comes from a tribe of valiant Indians who once inhabited the territory that is now Illinois.

MACROSIPHUM ILLINI var. CRUDAE new variety

ALATE AND APTEROUS VIVIPAROUS FEMALES

Structurally identical with the typical form of *illini*. Differs in having the basic color bright green instead of yellow.

Holotype.—Alate viviparous female; Decatur, Illinois, October 21, 1929, on *Helianthus* sp., (F. C. Hottes). Slide No. 10200. *Morphotype*.—Apterous viviparous female; same data as holotype. Slide No. 10201. *Paratypes*.—Six slides, containing alate and apterous females; same data as holotype. Slides Nos. 4786, 10202-10205, 10718.

MACROSIPHUM ILLINI VAR. SANGAMONENSIS new variety

ALATE AND APTEROUS VIVIPAROUS FEMALES

Structurally identical with the typical form of *illini*, but differing in having the basic color bright red instead of yellow.

Holotype.—Alate viviparous female; Decatur, Illinois, October 21, 1929, on *Helianthus* sp., (F. C. Hottes). Slide No. 10194. *Morphotype*.—Apterous viviparous female; same data as holotype. Slide No. 10195. *Paratypes*.—Four slides, containing alate and apterous viviparous females and nymphs; same data as holotype. Slides Nos. 10196-10199.

MACROSIPHUM IMPATIENSICOLENS PATCH

Macrosiphum impatiensicolens Patch, Maine Agricultural Experiment Station, Bulletin 282, December, 1919, p. 210.

This species has never been previously reported from Illinois. We have had considerable difficulty in separating this plant louse from species belonging to the *ambrosiac* complex, and in our key have been forced to key it out on the basis of host plant. We have held it as a distinct species because specimens of our material have been determined as *impatiensicolens* by Dr. Patch. According to the original description and some of our material, the secondary sensoria on the third antennal segment average fewer in number than in *ambrosiac*. Possibly future biological studies will prove that the Illinois material we are recording as *impatiensicolens* is the same species as *ambrosiac*.

Data associated with our viviparous specimens are as follows: Mt. Carroll (June 25), Rock Island (June 24), Starved Rock State Park (June 12, 13), 1928; Jonesboro (June 23), Starved Rock State Park (Aug. 14, Sept. 10), 1929. Specimens collected on *Impatiens* sp.

MACROSIPHUM KICKAPOO new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.91. Head and thorax chiefly light greenish brown; anterior margin of head, areas around ocelli, and dorsum of meso- and metathorax darkest; ventral areas of head and prothorax lightest, translucent greyish. Dorsum of abdomen pellucid green, with three or four lateral light dusky brown patches anterior to cornicles; base of cornicles surrounded by a narrow whitish ring which in turn is surrounded by a dusky brown area, the two areas connected posteriorly by a transverse dusky band; posterior to this are two transverse dusky bands, the anterior band broad, the posterior band narrow and shorter. Cornicles pellucid greenish brown; cauda and anal plate light yellowish brown. First and second antennal segments concolorous with head; remaining antennal segments uniformly dusky brown except extreme base of third segment, which is lighter in color. Eyes reddish black. Coxae concolorous with thorax; trochanters and basal halves of fore femora yellowish, remainder of fore femora shading gradually to blackish brown; femora of middle and hind legs with only their extreme basal portions yellowish, remaining portions blackish brown; tibiae darkest at the knees, then gradually shading to dusky yellowish at about the middle and continuing this color to within a distance from the apex equal to the length of the tarsi, this short apical portion dark brownish; tarsi dark brown, first segment lighter than second. Fore wing with stigma light yellowish; veins of wings dark brown, anal and cubital veins much the stoutest and darkest and lightly bordered with brownish; posterior margin of wing where it meets anal vein suffused with brownish. Beak luteous with the exception of the extreme tip of the last segment which is dark brown.

Head and appendages.—Average width of head across eyes, .50. Antennal segments with comparative lengths as follows: III— .66 to .73, average .70; IV— .50 to .60, average .56; V— .53 to .64; average .58; VI— .16 to .19, average .17 plus .97 to 1.00, average .99. The secondary sensoria (Fig. 294) are entirely or almost all restricted to the third antennal segment, distributed about in a straight row and almost the entire length of the segment beginning at a distance from the base about equal to the length of the second antennal segment and ending very near the end of the segment; occasionally a secondary sensorium on the fourth segment; sensoria large, numbering from 16 to 20 and with an average of 18. The beak is short, failing to reach the coxae of the mesothoracic pair of legs.

Thorax and appendages.—Stigma of fore wing quite narrow and sharply pointed; second fork of media usually closer to the margin of the wing than it is to the first fork, but in a few specimens the reverse is true. The hind tarsi, exclusive of claws, are not quite equal to the length of the cauda.

Abdomen.—Cornicles (Fig. 109) with sides straight and tapering but slightly to the apex which is without a rim; apical one-fourth covered with closed reticulation, remaining portion strongly imbricated; in length they are a little more than twice the length of the hind tarsi exclusive of claws and average about .29. Cauda (Fig. 172) short, stout, non-constricted, about equal to the base of the sixth antennal segment in length or an average length of .18 with four pairs of hairs on a side.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.90. Entire body and appendages pellucid whitish green except the following parts: sixth antennal segment, tarsi, extreme tip of beak and reticulated apical portion of cornicles, all dusky brown; eyes dark reddish-black.

Head and appendages.—Average width of head across eyes, .47. Antennal segments with comparative lengths as follows: III— .64 to .79, average .72; IV— .39 to .50, average .44; V— .41 to .51, average .48; VI— .14 to .16, average .14 plus .81 to 1.00, average .88. Secondary sensoria limited to the third antennal segment, never farther removed from the base of the segment than one-half the length of the cornicles; numbering from one to three, two being the more common number. The beak may reach as far as the coxae of the metathoracic pair of legs but generally extends just to the mesothoracic pair of coxae or slightly beyond.

Thorax and appendages.—The hind tarsi are a little shorter than one-half the length of the cornicles, or subequal to the length of the base of the sixth antennal segment.

Abdomen.—Cauda similar to that of alate viviparous female except it has three hairs on a side. Cornicles and anal plate similar to the same structures of the alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.11. This form in color and markings is practically identical with the apterous viviparous female.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with the following proportions: III— .61 to .66, average .64; IV— .41 to .51, average .46; V— .44 to .50, average .47; VI— .13 to .14, average .14 plus .77 to .90, average .83. Other characters as in apterous viviparous females.

Thorax and appendages.—Posterior tibiae but slightly swollen with numerous sensoria on basal half which are difficult to count owing to clearness of legs. Otherwise as in apterous viviparous female.

Abdomen.—Similar to the apterous viviparous female, with the exception of apical modifications and cauda which is much shorter and stouter.

ALATE MALE

Size and general color.—Average width of head across eyes, .49. Average length from vertex to tip of anal plate, 1.35. Color and markings almost

identical with the alate viviparous female, differing only in that the lateral spots on the abdomen are more nearly confluent and that there is less brown on the posterior region of the abdomen since the white extends farther back on the dorsum than the base of the cornicles.

Head and appendages.—Antennal segments with the following comparative lengths: III— .43 to .71, average .59; IV— .33 to .50, average .43; V— .36 to .54, average .45; VI— .11 to .14, average .12 plus .69 to 1.01, average .88. Secondary sensoria found on third, fourth, and fifth antennal segments; varying greatly in size, those on fourth and fifth segments being uniformly small while those on third segment vary from large to small, the smaller sensoria outnumbering the large ones on third segment. Sensoria are distributed as follows: III— 26 to 35, generally more than 30; IV— 7 to 11; V— 7 to 16, generally more than 9. On the fourth and fifth segments the sensoria are nearly in a straight line; on the third segment they are scattered although confined largely to one side of the segment and often quite crowded and close together.

Thorax and appendages.—Similar to alate viviparous female.

Abdomen.—Essentially as in alate viviparous female. Male genitalia dark dusky brown.

Holotype.—Alate viviparous female; Starved Rock State Park, Illinois, August 14, 1929, on *Polygonatum* sp., (Frison and Hottes). Slide No. 10313. *Allotype.*—Alate male; Same data as for holotype. Slide No. 10314. *Morphotype.*—Apterous viviparous female; Same data as for holotype. On slide with two other apterous viviparous females. Slide No. 10315. *Morphotype.*—Apterous oviparous female; Starved Rock State Park, Illinois, September 10, 1929, on *Polygonatum* sp., (Frison and Ross). On slide with male and two other oviparous females. Slide No. 10316. *Paratypes.*—Twenty-eight slides of males, oviparous females, apterous and alate viviparous females, nymphs and pupae; collected on *Polygonatum* sp. by T. H. Frison, F. C. Hottes, and H. H. Ross, at Starved Rock State Park, Illinois, on August 14 and September 10, 1929, and May 13, 1930, and Seymour, Illinois, June 20, 1930. Slides Nos. 10317-10337 and others unnumbered.

This small *Macrosiphum* is not closely related to any of the previously described members of this genus. It is, however, closely allied to *M. sanguinarium* described as new in this paper. It differs from the latter species in the color of the abdomen, cornicles, and legs, and the alate viviparous females may be separated by the more numerous secondary sensoria on the third antennal segment.

The light coloration of this new species makes it easily detected on the lower sides of the green leaves of its host plant.

MACROSIPHUM LAEVIGATAE Essig

Macrosiphum laevigatae Essig, Pomona College Journal of Entomology, Vol. III, May, 1911, p. 548.

This pale yellowish green species, heretofore recorded only from California and Maine, was taken by us on the tender shoots of a species of *Salix* at Starved Rock State Park, July 6, 1929. Swain (1919) and Soliman (1927) have used the specific name of *californica* (Clarke) for this species, but the antennal measurements do not agree with the original description of Clarke (1903). The sexual forms are unknown.

MACROSIPHUM LIRIODENDRI (MONELL)

Siphonophora liriodendri Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, Art. 1, January 22, 1879, p. 20.

Davis (1909b) first reported this species from Illinois. It is very abundant on the undersides of the leaves of the tulip tree in all parts of the state. Good technical descriptions of all forms are given by Davis (1909b). The red color phase of this aphid was named *rufa* by Monell.

Data associated with our viviparous specimens are as follows: Champaign (June 26), Urbana (June 21, 24), 1886; Urbana (July 2), 1891; Champaign (July 30), 1894; Herod (Oct. 12), Urbana (Oct. 15, 23), 1928; Bloomington (July 5), Cairo (June 22), Decatur (June 12), Elizabethtown (June 20), Grayville (June 19), Jonesboro (Sept. 26), Metropolis (Sept. 28), Richmond (July 12), and Woodriver (June 25), 1929. Sexual forms have been collected as follows: Decatur (Oct. 20), Herod (Oct. 12), Urbana (Oct. 15), 1928; and Urbana (Oct. 9), 1929. All specimens collected on *Liriodendron Tulipifera*.

MACROSIPHUM LUDOVICIANAE (OESTLUND)

Siphonophora ludoviciana Oestlund, Fourteenth Annual Report of the State Geologist of Minnesota, March, 1886, p. 23.

This species has not previously been reported from Illinois. We have found it present in almost every patch of wormwood examined. It shows a decided preference for the terminal portions of the plant. The sexual forms are unknown. The viviparous forms are best described by Soliman (1927). Specimens of our material have been determined by Professor Oestlund as this species (actual types lost).

Data associated with our viviparous specimens are as follows: Benton (Sept. 26), Champaign (Aug. 13), Erie (July 9), Herod (Sept. 27), LeRoy (Aug. 14), Mattoon (Sept. 10), Rock Island (July 7), Urbana (Aug. 5), Vandalia (Sept. 28), Witt (Sept. 10), 1929; Metropolis (April 17), 1930. All specimens collected on *Artemisia* sp.

MACROSIPHUM PALLENS new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.89. Head, thorax and abdomen a pale yellow-green, except for small brownish areas immediately surrounding ocelli. Cornicles concolorous with abdomen for a little over one-half their length, apical half light fuscous; cauda and anal plate concolorous with abdomen. First antennal segment concolorous with the head except inner apical margin somewhat brownish, second and base of third segment for a distance equal length of second segment pale yellowish, remainder of antennae dark brownish. Coxae, trochanters, and basal half of femora concolorous with abdomen; apical portion of femora and remainder of legs brownish, particularly apices of femora, tibiae, and all of tarsi. Beak, except for brownish tip, concolorous with head. Stigma of fore wings delicately fuscous, veins light brown, posterior margin of wing brownish near junction with anal vein.

Head and appendages.—Average width of head across eyes, .47. Antennal segments with comparative lengths as follows: III— .90; IV— .87; V— .91; VI— .23 plus 1.43. Secondary sensoria (Fig. 289) limited to the third antennal segment, small, arranged in a straight row and extending along the entire length of the segment, numbering from 12 to 15. Hairs on the antennae exceedingly fine and short, arising from conspicuous translucent areas, and might easily be overlooked were it not for these areas. Primary sensorium on the sixth antennal segment apparently without marginal sensoria. Beak just failing to reach to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Fore wing with the second fork of media closer to the margin of the wing than to the first fork. Medial and cubital veins failing to reach the margin of the wing.

Abdomen.—Cornicles (Fig. 112) long, tapering very gradually from base to apex; with three or four rows of closed reticulations at apex followed by faint imbrications; well-developed flange at apex; about one-half as long as terminal filament of sixth antennal segment and twice as long as cauda, measuring .61 in length. Cauda (Fig. 175) distinctly constricted near middle, measuring .29 in length, with three hairs on each side. Anal plate normal for genus.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.40. Entire body except appendages an immaculate light green. Cornicles, cauda, and anal plate lighter in color than the abdomen; cornicles with the extreme apex faintly fuscous. First and second antennal segments, and base of third segment to point where the sensoria begin, concolorous with the head; remainder of third and following antennal segments yellowish brown, with apical portions of each segment and the portion of the sixth segment around the primary sensorium somewhat darker. Coxae, trochanters, and basal half of femora essentially concolorous with the body, remainder of femora darker towards apex; tibiae light brownish except apices, which are concolorous with the dark brownish tarsi.

Head and appendages.—Average width of head across eyes, .50. Antennal segments with comparative lengths as follows: III— .80 to .99, average .89; IV— .80 to .93, average .88; V— .64 to .74, average .71; VI— .20 to .26, average .23 plus .93 to 1.39, average 1.21. Secondary sensoria small, arranged in a straight row and confined to about the basal one-third of the segment; varying from three to four in number, four being the more common number. Beak similar to that of the alate viviparous female.

Abdomen.—Cornicles similar to those of the alate viviparous female and averaging .73 in length. Cauda less constricted than in the alate viviparous female, with from three to four hairs on a side, averaging .38 in length.

Holotype.—Alate viviparous female; Galena, Illinois, July 10, 1929, on *Silphium integrifolium*, (Frison and Hottes). Slide No. 10206. *Morphotype.*—Apterous viviparous female; Galena, Illinois, July 10, 1929, on *Silphium integrifolium*, (Frison and Hottes). On slide with two apterous viviparous females and two nymphs. Slide No. 10207. *Paratypes.*—Four slides of alate and apterous viviparous females, nymphs and pupae. Galena, Illinois, July 10, 1929, on *Silphium integrifolium*, (Frison and Hottes), and Danville, Illinois, July 15, 1928, on *Ambrosia trifida*, (Hottes, Ross, and Park). Slides Nos. 10208-10211.

Mounted specimens of this species have a superficial resemblance to a number of green-colored species of *Macrosiphum*. This new species is very closely allied to *M. pelargonii* (Kalt.), but is distinguished by its pale whitish-green color in life, and by having the third, fourth, and fifth antennal segments subequal. It is also allied structurally to *M. shranki* Theobald, from which it may be distinguished by having fewer secondary sensoria on the third antennal segment, and the sensoria being in a row. The absence of marginal sensoria on the sixth antennal segment, the absence of marginal spots on the abdomen of the alate viviparous females, and the more uniformly green body in general and the brownish tibiae, are further differential characters. This species may be distinguished at once from *M. gei* (Koch) and *pisi* (Kalt.) by the poorly reticulated cornicles and the constricted cauda.

The specimens were found scattered here and there on the lower surfaces of the broad leaves of their host plant.

MACROSIPHUM PISI (KALTENBACH)

FIGS. 36, 37, 181

Aphis pisi Kaltenbach, Monographie der Familien der Pflanzenläuse, Aachen, 1843, p. 23.

The cosmopolitan pea aphid (Figs. 36 and 37) is one of the commonest and most widely distributed aphids in Illinois. Since it is often a serious pest of peas, clovers, and other legumes, it has received much attention from economic entomologists. This species was first recorded from Illinois (Carbondale) by Thomas (1879).



Fig. 36. (Left) Apterous viviparous female of the pea aphid, *Macrosiphum pisi* (Kaltenbach). (After Folsom: Ill. Ent. Rep. 25.)

Fig. 37. (Right) Alate viviparous female of the pea aphid, *Macrosiphum pisi* (Kaltenbach). (After Folsom: Ill. Ent. Rep. 25.)

Davis (1915) and Theobald (1926) have given very complete descriptions of all forms of this plant louse and much information concerning its biology. The article by Folsom (1909) contains data relating to the life history of the pea aphid in Illinois and an especially good discussion of its natural enemies. The following summarized statement of the life history of this species is quoted from Davis:

"The life history of the pea aphid is quite simple, for it does not have a true alternate host like some species of plant-lice. As has been noted, it attacks leguminous plants primarily, some of which are annuals, others perennials. Clovers, particularly red and crimson clovers, serve as hosts for this insect the entire year, and it is on these plants that it usually passes the winter, either as eggs or as viviparous females, although during the summer months the migrants also pass to other leguminous crops, such as sweet pea, garden and field peas, and vetches, and on these they multiply very rapidly, oftentimes destroying large acreages. In the latitude of LaFayette, Ind., the species winters both as living viviparous females, usually wingless, and as eggs. Farther north it may winter exclusively in the egg stage, although our observations are not complete on this point, while farther south, in the latitude of Tennessee, the sexual forms which lay the overwintering eggs are rare, the insect ordinarily passing the winter as living plant-lice, both wingless and winged forms being able to withstand the lower temperatures in that latitude. Still farther south we know only the viviparous females and our observations lead us to believe that the species may reproduce viviparously indefinitely in localities where the winters are quite mild."

Data associated with our viviparous specimens are as follows: Harvey (Sept. 15), 1907; Albion (May 26), Antioch (June 15), Bement (July 17), Cairo (June 2), Carbondale (June 4), Champaign (July 9), Elizabethtown (May 31), Galena (June 25), Havana (June 21, 22), Herod (May 29), Jacksonville (May 11), Kankakee (June 24), Marshall (May 25), Metropolis (June 1), Mounds (June 2), Mt. Carmel (May 26), Muncie (Oct. 6), Oakwood (May 21), Oregon (June 29), Pekin (June 20), Quincy (June 7), Rock Island (June 23), Shawneetown (May 27), Starved Rock State Park (June 13), Urbana (May 29), 1928; Cairo (June 22), Edwardsville (Sept. 11), Elizabethtown (June 20), Farmer City (July 5), Galena (July 10), Grayville (June 19), Hardin (June 25), Homer (June 17), Kansas (June 17), Olney (June 18), Oregon (June 11), Orleans (April 15), Richmond (July 12), Seymour (June 13), Springfield (May 2), and Urbana (July 22), 1929.

Specimens collected on *Carex* sp., *Celastrus* sp., *Lathyrus* sp., *Medicago sativa*, *Melilotus alba*, *Melilotus officinalis*, *Pisum sativum*, *Polygonum Muhlenbergii*, *Solanum dulcamara*, *Trifolium pratense*, *Trifolium procumbens*, *Trifolium repens*, *Trifolium* sp., and *Vicia* sp.

MACROSIPHUM PSEUDOROSAE PATCH

Macrosiphum pseudorosae Patch, Maine Agricultural Experiment Station, Bulletin 282, December, 1919, p. 206.

Although *Macrosiphum pseudorosae* has not previously been reported from Illinois, it is widely distributed throughout the state. No doubt it has been confused with the related *M. gei* (Koch). *Nectarophora pallida* Oestlund (1887) may be this species, but if so the name is preoccupied by *pallida* (Walker) and hence is not available. Like *M. gei*, this aphid has pink and green forms. The sexual forms have not as yet been described.

Data associated with our viviparous specimens are as follows: Havana (June 21), Herod (May 31), Kankakee (July 15), Starved Rock State Park (June 12), 1928; Decatur (Sept. 21), Herod (Sept. 27), Kappa (Sept. 9), Mahomet (Aug. 7, 17), Oakwood (Aug. 4, Oct. 17), Rock Island (July 7), Starved Rock State Park (Sept. 10), 1929; Grand Detour (May 16), Starved Rock State Park (May 13), 1930. Specimens collected on *Aruncus sylvestris*, *Gaura biennis*, *Gaura* sp., *Geum canadense*, *Impatiens*, *Oenothera biennis*, *Potentilla* sp., and *Rosa* sp.

MACROSIPHUM PTERICOLENS PATCH

Macrosiphum ptericolens Patch, Maine Agricultural Experiment Station, Bulletin 282, December, 1919, p. 210.

This species has never been recorded outside of Maine. We have found apterous viviparous females at Galena, July 10, 1929, on the fronds of *Asplenium Filix-femina*, which we take to be this species. It was originally described from alate viviparous females. Dr. Patch has seen specimens of our material and writes they "are probably this species."

MACROSIPHUM PURPURASCENS (OESTLUND)

Nectarophora purpurascens Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 81.

This species has not previously been reported from Illinois. It has the peculiar habit of producing the sexual forms early in the year and later in the season it is to be found in the egg stage only. It is a

leaf feeding species frequenting meadow rue. The male and oviparous forms of this species have never been described, and their descriptions are presented here.

Data associated with our viviparous specimens are as follows: Galena (June 25), Herod (May 29), Oakwood (May 12, 21), Oregon (June 28), Quincy (June 6, 16), Starved Rock State Park (June 13), 1928; Urbana (June 1), 1929; Oakwood (May 9), 1930. Sexual forms were collected at Quincy (June 16), 1928, and at Urbana (June 1), 1929. All specimens collected on *Thalictrum* sp.

ALATE MALE

Average length from vertex to tip of anal plate, 1.35. Color essentially similar to that of alate viviparous female. Comparative lengths of antennal segments as follows: III—.71 to .83, average .77; IV—.53 to .56, average .55; V—.43; VI—.14 plus .33. Secondary sensoria distributed as follows: III—94, IV—41, V—23; sensoria on third and fourth segments covering entire segment, those on fifth segment confined largely to one side of the segment. Cornicles .37 long, cauda .14 long, both structures similar in shape to those of the alate viviparous female. Genitalia dark brown.

APTEROUS OVIPAROUS FEMALE

Average length from vertex to tip of anal plate, 1.74. General color essentially similar to that of apterous viviparous female. Average width of head across eyes, .50. Comparative lengths of antennal segments as follows: III—.51 to .63, average .56; IV—.30 to .53, average .40; V—.29 to .34, average .31; VI—.11 to .14, average .12 plus .44 to .50, average .47. Secondary sensoria confined to third antennal segment, numbering 9 to 16, averaging 12. Cornicles .58 long, cauda .27, not constricted. Hind tibiae with the basal two-thirds swollen and with about 65 sensoria.

Allotype.—Alate male; Slide No. 6542, Urbana, Illinois, June 1, 1929, on *Thalictrum* sp., (T. H. Frison). On slide with oviparous females and nymphs. *Morphotype*.—Apterous oviparous female; Slide No. 5109, Quincy, Illinois, June 16, 1928, on *Thalictrum* sp., (Frison and Hottes). On slide with alate viviparous female, oviparous females and nymphs.

MACROSIPHUM RIBIELLUM DAVIS

Macrosiphum ribiellum Davis, Canadian Entomologist, Vol. LI, No. 10, Oct., 1919, p. 231.

The ornamental currant aphid is common and generally distributed throughout Illinois. It was first reported from Illinois (Chicago) by Davis (1909b) under the name of *M. cynosbati* (Oestlund), which was a misidentification. All forms of this plant louse have been well described by Davis (1909b, 1919). Quaintance and Baker (1917) have briefly chronicled the seasonal history as follows:

"This species usually occurs on the ornamental currants. The eggs hatch in the spring and numerous generations of wingless forms are produced. By August these are present in large numbers on the tender terminal twigs and to a less extent on the undersides of the leaves. Winged forms appear in September or earlier and ants are found attending the insects. Early in October the orange, wingless, egg-laying females may be found mating with the winged males and the eggs are laid shortly afterward."

A cotypic slide (No. 4535) of this species has been deposited in the Survey collection through the kindness of Professor J. J. Davis.

Data associated with our viviparous specimens are as follows: Urbana (July 26, Aug. 2), 1928; Chicago (July 14), El Paso (July 5), Galena (July 10), Lawrenceville (June 18), Macomb (May 4), Rock Island (July 9), and Woodriver (June 25), 1929. Sexual forms were taken at Urbana (Nov. 5), 1929. All collected on *Ribes odoratum* and *Ribes* sp.

MACROSIPHUM ROSAE (LINNAEUS)

Aphis rosae Linnaeus, Systema Naturae, Editio Decima, 1758, p. 452.

The rose aphid has been doubtfully recorded by Thomas (1879) from Illinois and positively so by Davis (1911b). It is common and



Fig. 38. A colony of *Macrosiphum rudbeckiae* (Fitch) on golden glow, *Rudbeckia laciniata* var. *hortensia*; Champaign, June 10, 1929.

generally distributed throughout the state both out of doors and in greenhouses on wild and cultivated roses. Patch (1919) states that it is "not known to migrate and does maintain a continuous residence upon the rose." Theobald (1926), however, lists a few other plants as hosts of this species. This species has pink and green varieties in common with *M. gei* and *M. pseudorosae*. It is partial to the tender shoots and leaves of the rose.

Good descriptions of all forms are given by Theobald (1926) and of the viviparous forms by Essig (1911b) and Soliman (1927).

Data associated with our viviparous specimens are as follows: Carbondale (June 4), Galena (June 27), Kankakee (June 29), Marshall (May 25), Oregon (June 28), Pekin (June 20), Quincy (June 6), Rock Island (June 23), St. Joseph (June 17), Urbana (May 23, Oct. 1), 1928; Casey (June 17), Chrisman (June 6), Edwardsville (Sept. 11), Granite City (June 25), Homer (June 17), Starved Rock State Park (July 6), Urbana (Nov. 5), Witt (Sept. 10), 1929; Edgebrook, in greenhouse (Feb. 28), and Oregon (May 16), 1930. Oviparous females were collected at Urbana (Nov. 5), 1929. All collected on *Rosa* sp.

MACROSIPHUM RUDBECKIAE (FITCH)

FIG. 38

Aphis rudbeckiae Fitch, Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 86.

This large vermilion aphid (Fig. 38) is very common and widespread throughout Illinois. Very few clumps of golden glow

escape being attacked by it, and the stems are frequently covered for much of their length with these aphids standing head downwards. It was first recorded from Illinois by Thomas (1879). Our records indicate that it is not a true migratory species.

The best descriptions of the viviparous forms are those by Essig (1911a) and Soliman (1927). Weed (1888) has described sexual forms under the name of *rudbeckiae*, but his discussion indicates he may have had two species confused.

Data associated with our specimens are as follows: Normal (June 22, 1903; Albion (May 26), Cairo (June 2), Carbondale (June 4), Danville (July 15), East Dubuque (June 26), Elizabethtown (May 29), Havana (June 21), Herod (May 29, 31), Homer Park (Oct. 23), Jacksonville (June 18), Kankakee (June 29), LeRoy (June 20), Marshall (May 25), Metropolis (May 31), Mt. Carroll (June 25), Neoga (June 10), Oakwood (May 21, 25), Oregon (June 27), Pekin (June 20), Quincy (June 6), Rock Island (June 24), Shawneetown (May 27), Starved Rock State Park (June 13), Urbana (June 14, Oct. 5), 1928; Beach (July 13), Jerseyville (June 25), Kansas (June 17), Monticello (May 24), Newton (June 16), Oakwood (Oct. 17), and Putnam (May 5), 1929. Specimens collected on *Ambrosia* sp., *Eupatorium urticifolium*, *Helianthus* sp., *Hieracium venosum*, *Rudbeckia laciniata* var. *hortensia*, *Silphium perfoliatum*, *Solidago canadensis*, *Solidago nemoralis*, *Solidago* sp., and *Sorochus* sp. Sexual forms taken at Homer Park (Oct. 23), 1928, and Oakwood (Oct. 17), 1929, on *Rudbeckia* sp.

MACROSIPHUM RURALIS new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.90. Head, thorax, and abdomen essentially green, but head and particularly the mesothorax often brownish green and abdomen a very dark green. Cornicles dark brown to black and often with a greenish tinge, particularly near apex; cauda dark brown to black except area covered by anal plate, which is concolorous with abdomen; anal plate concolorous with abdomen. Antennae with first, second, and very base of third segment almost concolorous with head, except that inner margin of first segment dark brown; remainder of third and following segments dark brown to almost black. Coxae and trochanters light green; basal halves of femora pale whitish green, remainder of femora and following segments dark brown or black. Beak with basal part concolorous with thorax; apical two-thirds dark brown, except for a narrow light-colored band on the long middle segment. Eyes dull reddish brown. Stigma of fore wings dark brown, veins fine, posterior margin of wing brownish near junction with anal vein.

Head and appendages.—Average width of head across eyes, .60. Antennal segments with comparative lengths as follows: III—1.00 to 1.29, average 1.13; IV—.99 to 1.16, average 1.09; V—.91 to 1.09, average 1.02; VI—.23 to .26, average .24 plus 1.57 to 1.69, average 1.61. Secondary sensoria (Fig. 286) restricted to the third antennal segment, chiefly confined to one side of the basal two-thirds of the segment, irregular in arrangement, numbering from 13 to 27 and averaging about 18. Beak extending to or slightly beyond the hind coxae.

Thorax and appendages.—Stigma of fore wings rather narrow and sharply pointed at apex; second fork of media closer to margin of wings than to first fork.

Abdomen.—With four pairs of small lateral tubercles, the pair just anterior to the cornicles being the largest, no lateral tubercles posterior to cornicles. Cornicles (Fig. 115) rather long, base nearly twice as wide as middle or apex, varying in length from 1.13 to 1.29 and averaging 1.21; closed reticulations at apex occupying about one-fourth of length; flange feebly developed. Cauda (Fig. 185) about one-half the length of the cor

nicles, varying in length from .50 to .66 and averaging .61; but slightly constricted near base; with about seven hairs on a side. Anal plate rounded and not much wider than base of cauda.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.93. General color of body and appendages similar to alate viviparous female except as follows: femora mostly light yellowish green, with only apical one-fourth or less dark brown.

Head and appendages.—Average width of head across eyes, .61. Antennal segments with comparative lengths as follows: III— .97 to 1.19, average 1.10; IV— .69 to 1.13, average .95; V— .64 to 1.00, average .90; VI— .20 to .24, average .22 plus .76 to 1.51, average 1.09. Secondary sensoria restricted to basal one-third of third antennal segment, beginning about length of second antennal segment from base and continuing irregularly on one side of segment; varying from 5 to 17 in number and averaging about 10. Otherwise similar to alate viviparous female.

Thorax and abdomen.—Except for lack of wings, similar to alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.76. Colored essentially as the apterous viviparous female.

Head and appendages.—Average width of head across eyes, .53. Antennal segments with comparative lengths as follows: III— .89 to 1.03, average .95; IV— .69 to .96, average .88; V— .71 to .89, average .82; VI— .17 to .23, average .20 plus .81 to 1.46, average 1.26. Secondary sensoria restricted to the third antennal segment, grouped basally on one side of the segment beginning about the length of second antennal segment from base and continuing for a distance equal to one-half or more of the segment, numbering from 8 to 18 and averaging about 10. Otherwise as apterous viviparous female.

Thorax and appendages.—Similar to apterous viviparous female except as follows: basal half of tibia swollen and covered with numerous sensoria, one specimen with about 250 sensoria.

Abdomen.—Cornicles, cauda, and anal plate essentially as in apterous viviparous female except average lengths are smaller.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.85. Colored essentially as in the alate viviparous female.

Head and appendages.—Average width of head across eyes, .53. Antennal segments with comparative lengths as follows: III— .80 to .93, average .85; IV— .77 to .89, average .82; V— .69 to .83, average .77; VI— .17 to .20, average .19 plus 1.29 to 1.43, average 1.36. Secondary sensoria present on third, fourth, and fifth antennal segments, with average distribution as follows: III— 36; IV— 15; V— 14. Sensoria on third segment concentrated chiefly on one side of segment though irregularly arranged; on fourth and fifth segments in a more regular row; scattered along almost entire length of segments, except more numerous on basal half of third segment. Beak extending to or beyond coxae of hind legs.

Thorax and appendages.—Similar to alate viviparous female.

Abdomen.—Essentially similar to that of alate viviparous female except for presence of dark brown hairy claspers; cornicles and cauda are shorter.

Holotype.—Alate viviparous female; Kappa, Illinois, August 14, 1929, on *Actinomeris alternifolia*, (Frison and Hottes). Slide No. 10050. *Allotype.*—Alate male; Oakwood, Illinois, October 13, 1929, on *Actinomeris alternifolia*, (Frison). Slide No. 10051. *Morphotype.*—Apterous viviparous female; Same data as for holotype. Slide No. 10052. *Morphotype.*—Apterous oviparous female; Decatur, Illinois, October 5, 1929, on *Actinomeris alternifolia*, (Hottes). Slide No. 10053. *Paratypes.*—Eighty-eight slides of alate and apterous viviparous females, oviparous females, males, pupae and

nymphs: all collected in Illinois by T. H. Frison, F. C. Hottes, and H. H. Ross, on *Actinomeris alternifolia* and once on *Helianthus* sp. The localities and dates are as follows: Elizabethtown (May 31), Herod (October 12), and Marshall (May 25), 1928; Choat (September 28), Decatur (September 22 and October 5), Herod (September 27), Kappa (August 14 and September 9-22), Oakwood (October 13), and Pana (August 10), 1929; Mounds (Horseshoe Lake—April 4) and Urbana (May 12), 1930. Slides Nos. 10054-10102 and others unnumbered.

This new species is very suggestive of specimens of *Macrosiphum ambrosiae* (Thomas) which are lighter and greener in color than normal. Mounted specimens, nevertheless, are easily separated from *ambrosiae* because of the dark cauda and the longer and more slender cornicles in addition to other finer characters. It is not altogether impossible that this new form is an off-shoot of *ambrosiae* which has been modified through host selection. With regard to our present paucity of knowledge of the limits of variation within this genus and the effects of host selection, it seems advisable to us to classify this new form as a new species.

All forms of this plant louse are found on the main stalks of the host plant, particularly near the top of the plant. In the case of plants heavily infested, the mature forms are often found beneath the leaves.

MACROSIPHUM SANBORNI GILLETTE

FIG. 106

Macrosiphum sanborni Gillette, Canadian Entomologist, Vol. XL, No. 2, February, 1908, p. 65.

The chrysanthemum aphid is one of the most common and destructive pests of chrysanthemum out of doors and in greenhouses. It was first recorded from Illinois by Davis (1911). The short, somewhat bottle-shaped cornicles are rather peculiar among the *Macrosiphum* and the species has been placed in the genus *Macrosiphoniella*, a complex which we have for the present considered as a subgenus. The best descriptions of the viviparous forms have been given by Gillette (1908) and Theobald (1926). To our knowledge the sexual forms have not been described.

Data associated with our viviparous specimens are as follows: Urbana (Dec. 3), 1906; Danville (Nov. 4), Decatur (Nov. 4), Elizabethtown (May 29, Oct. 12), Hutsonville (Nov. 29), Lawrenceville (Nov. 28), Neoga (June 10), Pekin (June 20), Quincy (June 5), Shawneetown (May 27), Urbana (Oct. 1), 1928; Cairo (June 22), Carbondale (June 21), Collinsville (Sept. 11), Grayville (June 19), Jonesboro (June 23), Oakwood (Nov. 7), 1929; Flora (Nov. 13), and Vandalia (Nov. 13), 1930. All collected on *Chrysanthemum* sp.

MACROSIPHUM SANGUINARIUM new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.72. Head and thorax, except intersegmental areas of thorax, which are ruby-red or yellow, a dark chocolate-brown. Abdomen with five rounded chocolate brown patches on each side anterior to cornicles; dorsum with transverse, segmentally arranged, chocolate-brown bars which become almost fused beginning with third segment and extending backwards to cauda;

remainder of body of abdomen ruby-red or yellowish. Cornicles variable, usually dark at base and with apical portions yellowish-white. Cauda ruby-red or yellowish. Anal plate brownish. Venter of body variable, either ruby-red to almost yellow with the mesosternum a chocolate-brown. Eyes reddish-brown. First and second segments concolorous with head, remainder yellowish-brown becoming almost black at apex and near primary sensoria. Coxae, trochanters, and extreme base of femora yellowish-white; remainder of femora brownish to black at apices; tibiae yellowish-white except the apices, which are black; tarsi black. Wings with stigma yellowish and veins light brown and delicate in structure. Beak concolorous with head at base, remainder yellowish-white except extreme tip is black.

Head and appendages.—Average width of head across eyes, .46. Antennal segments with comparative lengths as follows: III— .51 to .73, average .62; IV— .33 to .53, average .47; V— .43 to .56, average .50; VI— .17 to .21, average .18 plus .71 to 1.03, average .94. Secondary sensoria (Fig. 287) limited to the third antennal segment, arranged in a straight row, numbering from 5 to 10. They are not equally distributed throughout the length of the segment, usually failing to reach the end of the segment by a greater distance than the first sensorium is removed from the base of the segment. The hair on the antennae is very short and fine and not even equaling in length one-half the width of the segment. The beak just reaches the coxae of the mesothoracic pair of legs.

Thorax and appendages.—The fork of the fore wings is always closer to the margin of the wing than it is to the first fork.

Abdomen.—The cornicles (Fig. 105) taper very gradually from base to apex, they are very delicately reticulated for about one-third of their length, and in length they average a little less than three times the length of the cauda. The cauda is scarcely constricted if at all, and has from 3 to 4 hairs on a side. The measurements of the cornicles and cauda are as follows: length of cornicles, .30 to .50 with an average of .43; length of cauda, .11 to .21 with an average of .17.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Size and general color.—Average length from vertex to tip of anal plate, 1.77. Head with the exception of frontal areas, thorax, abdomen, cauda, and anal plate with exception of apical margin, an orange or ruby-red with paler patches due to pale embryos showing through body wall. Frontal areas of head, first and second antennal segments, coxae, and trochanters pale yellowish-orange. Cornicles and apical margin of anal plate a translucent whitish. Femora and tibiae whitish, the apices of the tibiae slightly infuscate; tarsi greyish black. Antennae beyond second segment white, with minute rings at apices of fourth and fifth segments and all of sixth segment black. Beak whitish with extreme apex black. Eyes deep purplish-red.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III— .50 to .57, average .54; IV— .19 to .30, average .27; V— .26 to .36, average .32; VI— .14 to .19, average .17 plus .46 to .57, average .51. Secondary sensoria lacking or, if present, confined to a single sensorium on the third antennal segment. Primary sensorium on sixth segment with a group of about five marginal sensoria on one side. All antennal segments faintly imbricated and with sparse setae. Antennal tubercles rather shallow. Beak extending to a point in middle of meso- and metathoracic coxae.

Thorax and appendages.—Hairs on legs fine and short, those on the tibia considerably shorter than the width of the segment.

Abdomen.—Cornicles long, straight, without flange at apex, reticulated at apex for a distance about one-sixth of total length, remainder imbricated, averaging about .46 in length. Cauda non-constricted, with apical portion rather blunt, usually with three inwardly curved setae on each side, averaging about .21 in length. Anal plate normal.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.58. Head pearly-white to light yellowish. In mounted material the thorax

and portion of abdomen anterior to cornicles and often entire abdomen dusky brown; in life this portion of the body is a bright, shining ruby-red the color probably being due to the red sap of the host plant; portion of abdomen posterior to cornicles often considerably lighter in color than the portion anterior to the cornicles. Cornicles and cauda uniformly yellowish-white. Antennae uniformly yellowish-white in most specimens; a few specimens have the apex of the fifth and all of the sixth antennal segments light-brownish or dusky. Coxae, trochanters, and femora with yellowish-white at base, the yellow becoming less intense towards the knees but never turning to brown, tibiae yellowish-white with a slightly dusky area at the apex about equal to the length of the tarsus; tarsi brownish. The beak is yellowish-brown tipped with darker brown at apex.

Head and appendages.—Average width of head across eyes, .39. Antennal segments with comparative lengths as follows: III— .46 to .71, average .58; IV— .36 to .50, average .41; V— .39 to .53, average .44; VI— .13 to .19, average .16 plus .71 to .89, average .44; VI— .13 to .19, average .16 plus .71 to .89, average .81. A single secondary sensorium is located on the third antennal segment at a distance from the base of the segment about equal to the length of the first antennal segment. The beak reaches about to the middle of the metathoracic pair of legs.

Thorax and abdomen.—Cornicles about three times as long as the tarsi. Cornicles, cauda, and anal plate are similar to these structures of the alate viviparous female. Length of cornicles, .39 to .53 with an average of .46. Length of cauda, .16 to .21 with an average of .18.

Nymph.—Light yellowish green with eyes reddish. Markedly contrasting in color with adults.

Holotype.—Alate viviparous female; Carbondale, Illinois, June 4, 1928, on *Sanguinaria canadensis*, (Frison and Hottes). Slide No. 10278. *Morphotype.*—Apterous viviparous female (fundatrix); Urbana, Illinois, May 3, 1930, on *Sanguinaria canadensis*, (Frison and Ross). Slide No. 10279. *Morphotype.*—Apterous viviparous female (virgogenia); Carbondale, Illinois, June 4, 1928, on *Sanguinaria canadensis*, (Frison and Hottes). Slide No. 10280. *Paratypes.*—Forty-one slides of alate and apterous viviparous females, pupae, and nymphs collected in Illinois on *Sanguinaria canadensis*, as follows: Anna, May 8, 1925 (Frison); Carbondale, June 4 (Frison and Hottes), Quincy, June 6 (Frison and Hottes), Oakwood, July 8 (Hottes and Ross), Danville, August 4 (Hottes and Ross), and Urbana, May 3, 12 and 21 (Frison and Ross), 1928. Five slides of alate and apterous viviparous females, pupae, and nymphs from St. Paul, Minnesota, on *Sanguinaria canadensis*, as follows: June 19, June 22, July 26, 1926 (Hottes). Slides Nos. 10281-10312 and others unnumbered.

This distinctive species feeds on the under surface of the leaves of its host, the blood-root. Specimens on the same plant are quite solitary in habit and seem to prefer locations near the larger veins except the small nymphs.

Aside from its generic affinities with *Macrosiphum* as a whole, this new species has no near relatives among the described species of this genus known to us. It does, however, show characters suggestive of a close relationship with a new species (*M. kickapoo*) described in this paper. It may be separated from *kickapoo* on the basis of the reddish color of the anterior portion of the abdomen, by the lack of dusky cornicles and dusky posterior portion of abdomen, by differences in color of legs, and by the third antennal segment having considerably fewer secondary sensoria.

MACROSIPHUM SCHRANKI THEOBALD

Aphis urticae Schrank, Fauna Boica, 1801, p. 106. Name preoccupied.
Macrosiphum schranki Theobald, British Aphides, Vol. II, 1927, p. 403. New name.

This pale yellowish-green aphid has not previously been reported from Illinois. It was taken on the undersides of the leaves of pigweed. Good descriptions of the viviparous females and the male are given by Theobald (1926). The oviparous female is unknown.

Data associated with our viviparous specimens are as follows: Oregon (July 11), and Rock Island (July 7), 1929. Specimens collected on *Amaranthus* sp.

MACROSIPHUM SONCHELLUM (MONELL)

Siphonophora sonchella Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, 1879, Art. 1, p. 21.

This species has not previously been reported from Illinois; in fact, it has been mentioned only a few times in literature since it was first described by Monell and these records are doubtful. Through the kindness of Professor J. J. Davis we have been permitted to compare alate specimens of our material with typic specimens of *sonchella*. A description is given of the apterous viviparous female since it never has been described. Supplementary descriptive notes concerning the alate viviparous female, not covered by the original description, are also presented.

Data associated with our slides of this species are as follows: Marshall (May 25), 1928; Mahomet (Aug. 7), and Urbana (Aug. 21), 1929. Specimens collected on *Lactuca* sp.

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.07. We have no record as to color. Dark markings essentially as described by Monell in original description except that dark brown to blackish more nearly satisfies the color of the darker markings in place of black.

Head and appendages.—Average width of head across eyes, .53. Comparative lengths of antennal segments as follows: III—1.54; IV—.46 to .47, average .46; V—.46 to .47, average .46; VI—.13 plus .97 to 1.00, average .98. Secondary sensoria confined to third and fourth antennal segments, small and very tuberculate, on the third segment numbering from 95 to 108, averaging 101, dotting the entire segment, on fourth segment numbering from 5 to 7, arranged in a more or less straight row. Primary sensorium on sixth antennal segment with a group of about 6 marginal sensoria at the side. Hairs on antennae short and spine-like, those on third segment somewhat enlarged at tip. Beak reaching to mesothoracic coxae.

Thorax and abdomen.—Prothorax without lateral tubercles. Cornicles .63 long, straight, with slightly more than the apical one-fourth covered with closed reticulations, remaining portion imbricated. Cauda .43 long, not constricted, with about five hairs on a side. Anal plate rounded.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.62. General color of body shining, deep brownish-red. Antennae, except for extreme base of third segment, dark brown. Legs, cornicles, and cauda as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .54. Antennal segments with the following comparative lengths: III—1.14 to 1.47,

average 1.33; IV— .33 to .54, average .45; V— .37 to .50, average .44; VI— .11 to .14, average .13 plus .59 to 1.07, average .86. Secondary sensoria (Fig. 298) confined to third and fourth antennal segments although often absent on the fourth; arranged as in alate viviparous female; numbering from 71 to 80, averaging 76, on the third segment and from 0 to 7 on the fourth.

Abdomen.—Cornicles .59 long, with an apical area equal to a little more than one-fourth their length, covered by closed reticulations, otherwise as in alate viviparous female. Cauda .48 long, with from three to six hairs on a side, otherwise as in alate viviparous female.

Morphotype.—Apterous viviparous female; Slide No. 7378, Marshall, Illinois, May 25, 1928, on *Lactuca* sp., (Frison and Hottes). On slide with alate and apterous viviparous females.

MACROSIPHUM TAPUSKAE new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.69. Head and most of thorax a greenish brown, prothorax slightly lighter in color. Abdomen and anal plate a light green except for a dark green dorsal band between and around bases of cornicles, which have basal one-fifth light green and remainder dark brown; cauda light yellowish green. First, second, and extreme basal portion of third antennal segments concolorous with head, remainder of segments brownish black. Coxae and trochanters a light green; femora with basal halves a light green gradually shading to dark brown at apex; tibiae with basal one-fifth light brown, middle three-fifths yellowish, and apical one-fifth dark brown; tarsi dark brown. Front wings with veins and edges of stigma black and conspicuous; body of stigma, base of costa and subcostal veins pale whitish-green; hind wings with veins delicately traced in brown. Beak with base concolorous with head, apex dark brown. Eyes red.

Head and appendages.—Average width of head across eyes, .50. Antennal segments with lengths as follows: III— .93; IV— .79; V— .64; VI— .17 plus 1.00. Secondary sensoria (Fig. 304) restricted to the third antennal segment, irregularly arranged but more abundant on one side than on the other, numbering 36 and 38. Fourth, fifth, and sixth antennal segments imbricated, all segments with a few hairs, not as long as width of segments, which are enlarged at tip. Primary sensoria on fifth and sixth segments, that on sixth segment with about seven small sensoria on one side. Beak reaching to middle of mesothoracic coxae.

Thorax and appendages.—The second fork of media closer to margin of wing than to first fork in one wing, in other wing media is forked only once; stigma rather narrow and bluntly pointed at extreme tip; veins not reaching margin of wings; posterior margin of fore wing thickened and dark where anal vein reaches margin of wing.

Abdomen.—Cornicles (Fig. 117) .86 in length, gradually tapering from base to a flangeless but somewhat dilated apex; base about twice the width of apex; closed reticulations at apex equal to about one-fourth total length, remainder of length imbricated. Cauda .39 in length, tapering to a blunt tip, lateral margins with from 2 to 4 hairs on a side. Anal plate normal.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 2.14. Head, thorax, abdomen, cauda, and anal plate apple-green. Cornicles concolorous with abdomen except tip, which is black for a distance about equal to length of tarsus. First and second antennal segments brownish green; third antennal segment concolorous with first and second segments about to first sensorium, which is removed from the base by a distance equal to the length of the second segment of the hind tarsi exclusive of claws; remaining portion of third segment and remaining segments uniformly dark brown or black. Coxae, trochanters, and basal halves of femora concolorous with abdomen and remaining portions shading to dark brown; in some cases the brown extends further basally on the dorsum of the femora; tibiae

with basal four-fifths (hind legs) or three-fourths (fore and middle legs) brownish green, remaining apical portion dark brown. Beak essentially concolorous with venter of thorax except its distinctly dark brown terminal segment. Eyes red.

Head and appendages.—Average width of head across eyes, .51. Antennal segment with comparative lengths as follows: III— .87 to 1.00, average .93; IV— .67 to .79, average .73; V— .53 to .57, average .55; VI— .16 to .17, average .16 plus .81 to .86, average .83. Secondary sensoria (Fig. 299) restricted to the third antennal segment, small, numbering from 8 to 13, located on the basal two thirds of the segment beginning at a distance from the base of the segment about equal to the first antennal segment; arranged almost in a straight row and when seen from the side they are rather tuberculate. The hairs on the antennae are somewhat enlarged and blunt at the tip. The beak reaches to, or just beyond, the coxae of the meta-thoracic pair of legs.

Thorax and appendages.—The hairs on the tibiae are long (about equal to the width of the tibiae), distinctly spine-like except for tip, which is usually blunt; hind tarsi, exclusive of claws, subequal in length to reticulated portion of cornicles.

Abdomen.—Cornicles widest at base, then gradually tapering towards apex except that apex is flared; apical half with imbrications poorly developed, closed reticulations of apical portion covering a distance equal to the hind tarsi of hind legs; averaging .82 in length. Cauda (Fig. 176) heavy, bluntly pointed, almost straight at the sides, with four pairs of lateral hairs, over twice as long as the length of the base of the sixth antennal segment or about one-half the length of the cornicles; averaging .38 in length. Anal plate short and wide.

APTEROUS VIVIPAROUS FEMALE (FUNDATRIX)

Similar to summer apterous viviparous female except for averaging slightly larger.

APTEROUS OVIPAROUS FEMALE

The oviparous female is essentially an exact counterpart of the apterous viviparous female and therefore no detailed description of this form will be given. Average length from vertex to tip of anal plate, 1.80. Average width of head across eyes, .47. Comparative lengths of antennal segments are as follows: III— .73 to 1.00, average .84; IV— .57 to .64, average .60; V— .46 to .50, average .49; VI— .11 to .17, average .15 plus .57 to .79, average .70. Secondary sensoria number from 8 to 11 and average 8.5. Sensoria on the hind tibiae occupy a little less than two-fifths of the total length of the tibiae, beginning at a distance from the base equal to the length of the hind tarsi; number varying from 15 to 38; area occupied by sensoria slightly swollen. Cauda is inclined to have more hairs than the apterous viviparous form.

Holotype.—Alate viviparous female; Metropolis, Illinois, April 17, 1930, on *Achillea Millefolium*, (Frison and Ross). Slide No. 10219. *Morphotype.*—Apterous viviparous female (virgogenia); Urbana, Illinois, October 7, 1929, on *Achillea Millefolium*, (Frison and Ross). Slide No. 10220. *Morphotype.*—Apterous viviparous female (fundatrix); Grayville, Illinois, April 15, 1930, on *Achillea Millefolium*, (Frison and Ross). Slide No. 10221. *Morphotype.*—Apterous oviparous female, Urbana, Illinois, October 16, 1929, on *Achillea Millefolium*, (Frison and Ross). On slide with two other oviparous females. Slide No. 10222. *Paratypes.*—Twenty-two slides of apterous viviparous females, oviparous females and nymphs; all collected in Illinois, on *Achillea Millefolium*, by T. H. Frison and H. H. Ross, as follows: Urbana (October 7, 15 and 16), 1929; Anna (April 19), Grayville (April 15), Harrisburg (April 16), Metropolis (April 17), Starved Rock State Park (May 13), 1930. Slides Nos. 10223-10241 and others unnumbered.

This new species superficially suggests certain other green species of *Macrosiphum* which have reticulated cornicles. It may be distinguished from these forms by the row of minute secondary sensoria on

the third antennal segment of the apterous viviparous female and the irregularly arranged sensoria of the alate female.

Because of a similarity in the green coloration of both host and insect, and its preference for the leaves close to the ground, this species is difficult to find. Another factor helping to explain why this species has been previously overlooked is its pronounced solitary habit. A good way to collect this species is to jar the leaves of the plant and then collect the aphids on the ground directly beneath the lower leaves.

MACROSIPHUM TARAXACI (KALTENBACH)

Aphis taraxaci Kaltenbach, Monographie der Familien der Pflanzenläuse, Aachen, 1843, p. 30.

As far as we are aware, this dark-colored aphid has not been previously recorded from Illinois. It occurs on the stems and leaves near the crown of its host, the dandelion. The sexual forms are unknown. Theobald (1926) and Soliman (1927) have given good technical descriptions of the viviparous females.

Data associated with our viviparous specimens of this species are as follows: LeRoy (June 20), Urbana (May 23, June 7), 1928; Champaign (May 28), Monticello (May 24), Starved Rock State Park (July 6), and Urbana (May 22), 1929. All specimens collected on *Taraxacum officinale*.

MACROSIPHUM TARDAE new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.17. Head, thorax, and abdomen uniformly dark blackish-red. Cornicles almost black, cauda concolorous with abdomen. Antennae brown; basal portion, except base of third segment, darkest. Legs dark reddish-brown shading to black with the exception of coxae and basal third of femora which are more yellowish-brown. Beak essentially concolorous with the head, apex somewhat darker. Fore wings with stigma brownish; veins light yellowish-brown, particularly yellowish near base; posterior margin of wing brownish near junction with anal vein.

Head and appendages.—Average width of head across eyes, .53. Antennal segments with comparative lengths as follows: III— .71 to .78, average .75; IV— .50 to .59, average .54; V— .44 to .64, average .46; VI— .14 to .23, average .17 plus .57 to .63, average .59. Secondary sensoria (Fig. 288) restricted to the third antennal segment, not uniformly distributed except for grouping on one side of segment, numbering from 28 to 40 and usually with more than 30. The beak extends to the coxae of the metathoracic legs.

Thorax and appendages.—Stigma of fore wings rather narrow and sharply pointed at apex; second fork of media in relation to first fork of media and margin of wings quite variable, but the second fork usually closer to margin of wings than to first fork.

Abdomen.—No lateral tubercles. Cornicles (Fig. 107) rather short and stout in comparison with most species of this genus, about equal to the length of the fourth antennal segment, varying from .47 to .57 and averaging .55 in length; usually reticulated at apex for about one-third of their length; flange slightly developed. Cauda (Fig. 182) about one-half as long as cornicles, varying from .28 to .36 and averaging .32 in length; slightly constricted in middle; with three to five pairs of hairs on a side. Anal plate rounded, extending almost to middle of cauda.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.37. General color of body and appendages as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .51. Antennal segments with comparative lengths as follows: III— .60 to .80, average .70; IV— .46 to .54, average .50; V— .29 to .48, average .38; VI— .10 to .17, average .14 plus .47 to .57, average .55. Secondary sensoria restricted to the third antennal segment; varying in number from 11 to 20, the most common number being less than 15; sensoria difficult to distinguish because of dark color of segment and large bases of stout setae; beginning to appear about the length of the second antennal segment from base and usually extending little if any beyond middle of segment. Beak extending to coxae of meta-thoracic legs.

Abdomen.—Cornicles considerably longer than fourth antennal segment, about as long as those of alate viviparous females, varying from .53 to .60 and averaging .57; much wider at base than those of alate viviparous females and bent slightly outwardly where reticulations begin; reticulated for at least one-third its length from apex; flange weakly developed. Cauda somewhat longer in proportion to cornicles than in the alate viviparous females, constricted near middle, with four to six hairs on a side. Otherwise as in alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 2.14. Head, thorax, and abdomen dark blackish-red; lateral portions sometimes slightly lighter in color, particularly so in the region around the thorax. Mounted specimens show the red replaced by brown. Cornicles almost black; cauda and anal plate dark dusky-brown. First and second antennal segments either concolorous with the head or darker; remainder of antennae dark blackish-brown, except that the third segment is usually somewhat lighter before first secondary sensorium. Femora with basal half yellowish-brown, abruptly shading to dark dusky-brown at their apex; tibiae dusky-brown, often darker near the base and apex; tarsal segments blackish. Beak fuscous with apical segments darkest.

Head and appendages.—Average width of head across eyes, .53. Antennal segments with comparative lengths as follows: III— .64 to .97, average .74; IV— .43 to .57, average .50; V— .36 to .51, average .45; VI— .14 to .17, average .16 plus .50 to .66, average .58. Secondary sensoria confined to the basal three-fourths of third segment, numbering from 13 to 19, averaging about 17, scattered along one side of the segment, large and with wide rims. The beak extends beyond the mesothoracic pair of coxae and may reach to or beyond the coxae of the metathorax.

Thorax and appendages.—Hind tarsi, exclusive of claws, subequal to the length of the base of the sixth antennal segment. Hind tibiae with basal two-thirds of segment swollen, this area covered with a variable number of sensoria which are very difficult to count; sensoria may exceed 60 in number.

Abdomen.—Cornicles tapering slightly from base to apex, sides nearly straight; reticulated at apex for a little less than one-third of their length, the reticulated area being equal to the length of the hind tarsal segments exclusive of claws; flange weakly developed. Cauda about two-thirds as long as the cornicles, about subequal to the length of the fourth antennal segment, or about three times as long as the base of sixth antennal segment; slightly constricted near middle; with five to eight hairs on a side. Anal plate similar to anal plate of the apterous viviparous female.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.62. Head, thorax, and abdomen brownish with a greenish tinge. Cornicles dusky green to dark brownish-black; cauda yellowish green; anal plate yellowish brown to dark brown. First and second antennal segments concolorous with head, remaining segments varying in color from light dusky green to dark brown. Femora with slightly less than basal half greenish yellow, remaining portion dark brown to black; tibiae dark brown, sometimes basal and middle area greenish yellow; tarsi dark. Hairs and bases of hairs on antennae and legs yellowish, contrasting to ground color of these

structures. Stigma brownish; veins near base yellowish brown, otherwise brownish, fine. Beak essentially concolorous with head except terminal segments more brownish.

Head and appendages.—Average width of head across eyes, .49. Antennal segments with comparative lengths as follows: III— .67 to .71, average .70; IV— .49 to .64, average .54; V— .43 to .57, average .49; VI— .14 to .14, average .14 plus .64 to .71, average .66. Secondary sensoria present on third, fourth, and fifth antennal segments, with average distribution as follows: III— 48; IV— 8; V— 8. Sensoria on third segment quite concentrated on one side of segment though irregularly arranged; on fourth and fifth segments in a more regular row, sensoria varying from small to large, but slightly tuberculate; distributed on third segment for almost its entire length except small area at base and apex, and on fourth and fifth segments starting just before middle and continuing almost to end of segments. The beak extends to the coxae of the metathoracic pair of legs.

Thorax and appendages.—Second fork of the media of fore wing much closer to the margin of the wing than it is to the first fork. Otherwise as in alate viviparous female.

Abdomen.—Cornicles tapering slightly from base to apex, with sides almost straight; in length two and one-half times as long as the base of sixth antennal segment, averaging about .36; reticulated for about one-fourth of their length, the remaining portion being distinctly imbricated. Cauda about three-fifths as long as the cornicles, constricted near middle, with from four to six hairs on a side. Anal plate rounded, extending to constricted part of cauda.

Holotype.—Alate viviparous female; Beach, Illinois, August 29, 1929, on *Helenium autumnale*, (Frison and Hottes). Slide No. 9984. *Allotype.*—Alate male; Seymour, Illinois, October 16, 1929, on *Helenium autumnale*, (Frison and Ross). Slide No. 9985. *Morphotype.*—Apterous viviparous female; same data as for holotype. Slide No. 9986. *Morphotype.*—Apterous oviparous female; same data as for allotype. Slide No. 9987. *Paratypes.*—Seventy-eight slides of alate and apterous viviparous females, oviparous females, males, pupae, and nymphs; all collected in Illinois by T. H. Frison, F. C. Hottes, and H. H. Ross from *Helenium autumnale*. The localities and dates are as follows: Mahomet (October 2), 1928; Beach (August 29), Kappa (September 9), Oakwood (October 17), and Seymour (July 20, August 6-21, September 16, October 7), 1929. Slides Nos. 9988-10036 and others unnumbered.

This *Macrosiphum*, because of its dark blackish-red color, superficially suggests in life *Macrosiphum sanborni* Gillette. A closer examination, however, enables one to immediately separate these two species on the basis of differences in cornicles and cauda.

All stages of this species are found on the stalks near the flower head and directly under the heads of the flowers. Often they are so concealed by the flower heads that their presence is easily overlooked.

MACROSIPHUM TILIAE (MONELL)

Siphonophora tiliae Monell, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Art. 1, p. 20.

This species, whose host is basswood, was first reported from Illinois (Chicago) by Davis (1911). According to our records the species is widely distributed throughout Illinois. It exhibits a fondness for the tender new shoots, particularly those around the base of the tree. Davis (1914) has given good descriptions of all forms.

Data associated with our viviparous specimens are as follows: Normal (May 29), 1884; Quincy (June 6), 1928; Chicago (July 13), Galena (July

10), Lisle (July 14), Rock Island (July 9), Starved Rock State Park (July 5), Urbana (July 2), Waukegan (July 13), 1929; and Carbondale (April 18), 1930. All collected on *Tilia americana*.

MACROSIPHUM VENAEFUSCAE DAVIS

Macrosiphum venaefuscae Davis, Canadian Entomologist, Vol. XLVI, No. 2, March, 1914, p. 77.

This species has not previously been recorded from Illinois. Our specimens were taken on common dock and were found on the undersides of the larger leaves close to the ground. According to Davis (1914), this species occurs in summer on *Polygonum* and the eggs are laid on *Rumex*. Good descriptions of all forms are given in the original description.

We do not agree with Theobald (1926) in placing this species in the synonymy of *M. gei* (Koch). In habitus this species is very suggestive of *M. gei* (Koch) but it may be separated on the alate viviparous females by the larger number of secondary sensoria on the third antennal segment, their irregular arrangement, and also by the fact that the third antennal segment is shorter than the fourth. In the apterous viviparous forms the third antennal segment is either equal to or shorter than the fourth segment—a condition not found in *M. gei* (Koch).

We have taken this species, viviparous females, only once at Urbana on Oct. 1, 1928, on *Rumex crispus*. A cotypic slide (No. 9466) of this species has been deposited in the Survey collection through the kindness of Professor J. J. Davis.

MACROSIPHUM ZINZALAE new species

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 2.46. Head and thorax dark dusky-green. Abdomen green with large dusky brown spots posterior to base of cornicles, and three pairs of very light and sometimes very small lateral dusky brown spots anterior to cornicles. Cornicles greenish black. Cauda yellowish green to yellowish brown, considerably lighter in color than the abdomen. Anal plate concolorous with abdomen. First and second antennal segments concolorous with head, remaining segments greenish brown except base of third which is lighter. Femora with basal halves pale yellowish green, apical halves greenish brown, darkest apically; tibiae dusky brownish at base gradually darkening towards apex, which is almost black; tarsi brown. Beak yellowish with the last segment brown. Stigma of fore wings light dusky brown; veins of wings the same, with just a suggestion of a border; posterior margin of fore wings in vicinity of anal vein brownish.

Head and appendages.—Average width of head across eyes, .60. Comparative lengths of antennal segments as follows: III—1.06 to 1.19, average 1.13; IV—1.04 to 1.23, average 1.14; V—.87 to .99, average .94; VI—.21 plus 1.21 to 1.29, average 1.24. Secondary sensoria (Fig. 291) confined to third antennal segment, tuberculate, irregularly arranged and varying greatly in size, numbering from 56 to 62, averaging 59. Primary sensorium on sixth antennal segment with a group of six small marginal sensoria on one side. Beak unusually long, extending well beyond metathoracic coxae, terminal segment one-third longer than base of sixth antennal segment.

Thorax and appendages.—Prothorax without lateral tubercles. Stigma of fore wings long and comparatively narrow, rather pointed at apex; second fork of media closer to margin of wing than to the first fork; all veins failing to reach margin of wing. Tibiae of legs with coarse spine-like hair.

Abdomen.—Cornicles (Fig. 120) 1.14 long, gently tapering from base to apex which is curved outwardly; flange present; apex covered with closed reticulations for from one-third to a little more than one-quarter the length of the cornicle. Cauda (Fig. 186) .53 long, usually not constricted but sometimes slightly so, with eight to ten hairs on a side. Cauda normal.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 2.71. Color essentially that of the alate viviparous female with these differences: head and thorax more greenish and less dusky; lateral spots on the abdomen lacking; femora yellowish green except for brownish apical portions.

Head and appendages.—Average width of head across eyes, .54. Comparative lengths of antennal segments are as follows: III—1.07; IV—1.03; V—.86; VI—.19 plus 1.14. Secondary sensoria (Fig. 290) restricted to third antennal segment, quite small and for the most part tuberculate; mostly confined to one side of segment; in numbers varying from 30 to 40; area free from sensoria at apical end equal to twice the length of base of sixth antennal segment. Primary sensorium on sixth antennal segment with group of about five marginal sensoria to one side. Beak with apical segment extending beyond metathoracic coxae.

Thorax and appendages.—Prothorax without lateral tubercles.

Abdomen.—Cornicles 1.10 long, in shape similar to those of alate viviparous female, apical two-sevenths covered by closed reticulations, portion of cornicles immediately anterior to reticulated area feebly imbricated, remainder smooth. Cauda .61 long, slightly constricted with about eight hairs on each side.

Holotype.—Alate viviparous female; Urbana, Illinois, May 12, 1930, on *Polymnia canadensis*, (H. H. Ross). Slide No. 10212. **Morphotype.**—Apterous viviparous female; same data as holotype. On slide with nymphs. Slide No. 10213. **Paratypes.**—Four slides containing alate viviparous females and nymphs, same data as holotype, and two slides containing apterous viviparous females and nymphs, same locality and host, May 3, 1930 (Frison and Ross). Slides Nos. 10214-10218 and one other unnumbered.

The alate form of this species runs in Soliman's key (1927) to *M. madia* Swain, from which it may be separated by the much longer beak, the more numerous secondary sensoria on the third antennal segment, and the different proportional lengths of the antennal segments. The apterous form keys to *M. albifrons* Essig from which it differs by the much longer beak, the coloration of the legs, the absence of hairs on the legs, and the comparative lengths of the antennal segments. This species feeds on the undersides of the leaves along the midrib.

GENUS MICROPARSUS PATCH

MICROPARSUS VARIABILIS PATCH

FIG. 96

Microparsus variabilis Patch, Entomological News, Vol. XX, No. 8, October, 1909, p. 338.

This species is here recorded from Illinois for the first time. It tightly curls the leaves of *Desmodium* and lives on the stems and undersides of the leaves of *Amphicarpa*. According to Patch (1909) the entire life cycle is passed upon *Desmodium*. Our collecting indi-

cates that the entire life cycle can also be passed upon *Amphicarpa*. The wing venation is somewhat variable.

Data associated with our viviparous specimens are as follows: Charleston (Aug. 24), 1910; Oakwood (Sept. 17), 1928; Edwardsville (Sept. 11), Mattoon (Sept. 10), 1929. Sexual forms have been taken at Decatur (Oct. 5), Edwardsville (Sept. 11), and Mattoon (Sept. 10), 1929. All forms collected both on *Desmodium* sp. and *Amphicarpa monoica*.

GENUS MYZUS PASSERINI

(SURGENERA MYZUS PASSERINI, NEOMYZUS VAN DER GOOT AND KAKIMIA HOTTES AND FRISON)

Key to the Species of the Genus *Myzus*

1. Cornicles much longer than width of head through eyes.....2
- Cornicles in length about equal to, or less than, width of head through the eyes.....3
2. Fore wing with second fork of media closer to margin of wing than to first fork; cubitus and anal veins distinctly outlined with a fuscous border; secondary sensoria on fourth antennal segment ranging from 5 to 8; alate and apterous forms with dorsum of abdomen uniformly a shade of green.....
..... *porosus* Sanderson p. 340
- Fore wing with second fork of media closer to first fork than to margin of wing or midway between them; cubitus and anal veins not distinctly outlined with fuscous border; secondary sensoria on fourth antennal segment ranging from 0 to 3; alate and apterous forms with dorsum of abdomen often with some dark markings, particularly apterous forms.....
..... *circumflexus* (Buckton) p. 335
3. Cornicles distinctly swollen.....4
- Cornicles not swollen.....8
4. Alate viviparous females [alate form of *scrophulariae* (Thomas) not known]5
- Apterous viviparous females.....6
5. Fore wings with veins distinctly outlined with a fuscous border; antennal tubercles projecting forward; minute brownish species *monardae* (Williams) p. 339
- Fore wings with veins not outlined with a fuscous border; antennal tubercles converging; medium-size species, usually with dark dorsal abdominal patch on lighter background.....
..... *persicae* (Sulzer) p. 339
6. Cornicles longer than width of head across eyes; first antennal segment with mesal margin very little produced, broadly and evenly rounded; yellowish-green forms..... *persicae* (Sulzer) p. 339
- Cornicles subequal to width of head across eyes; first antennal segment with mesal margin considerably produced, somewhat angulate towards apex of segment; brownish forms.....7
7. Cornicles with outer margin almost straight and with inner margin convex, the swelling therefore asymmetrical; flagellum of antennae longer than length of body from vertex to tip of anal plate..... *monardae* (Williams) p. 339
- Cornicles with both margins convex, producing a symmetrical swelling; flagellum of antennae slightly shorter than length of body from vertex to tip of anal plate.....
..... *scrophulariae* (Thomas) p. 343
8. Fourth antennal segment without secondary sensoria.....9
- Fourth antennal segment with secondary sensoria.....11

9. Fore wing with at least anal vein distinctly outlined with fuscous margin.....**plantagineus** Passerini p. 340
- Fore wings with no veins distinctly outlined with fuscous margin.....10
10. Primary sensorium on basal portion of sixth antennal segment about equal in size to one or two of surrounding sensoria; cornicles distinctly imbricated throughout; blackish and brownish form.....**cerasi** (Fabricius) p. 335
- Primary sensorium on basal portion of sixth antennal segment conspicuously larger than small surrounding sensoria, which are uniform in size; cornicles not distinctly imbricated throughout; dark dorsal abdominal patch on lighter background**persicae** (Sulzer) p. 339
11. Fifth antennal segment with few secondary sensoria (0 to 5).....12
- Fifth antennal segment with sensoria more numerous (7 to 20).....14
12. Cornicles much longer than fifth antennal segment.....
.....**lactucae** (Schrank) p. 338
- Cornicles shorter than fifth antennal segment.....13
13. Cornicles and cauda of equal length.....**houghtonensis** (Troop) p. 338
- Cornicles distinctly longer than cauda..**essigi** Gillette & Palmer p. 337
14. Fifth antennal segment with more than fifteen secondary sensoria; tibiae uniformly brown or dark...**heucherae** (Thomas) p. 337
- Fifth antennal segment with less than fifteen secondary sensoria; tibiae with extreme apex much darker than remaining portion**thomasi** n. sp. p. 343

MYZUS CERASI (FABRICIUS)

FIG. 39

Aphis cerasi Fabricius, Systema Entomologiae, 1775, p. 734.

The black cherry aphid, a well-known and cosmopolitan species (Fig. 39), is at times of considerable economic importance to cherry growers. It is very widely distributed in Illinois and was first reported from the state by Thomas (1879). Many articles have been written concerning it, but conclusive evidence that it is at least partially migratory has been obtained only recently (Ross, 1917, Wimshurst, 1925). *Galium* and *Lepidium*, in addition to cherry as an all year host, have been found to serve as summer hosts of this species in North America. Technical descriptions of all forms may be found among others in Gillette (1908b) and Theobald (1926).

Data associated with our viviparous specimens are as follows: Normal (May 24), 1883; Normal (May 13, July 18), 1884; Carbondale (June 2), Mattoon (June 10), Mt. Carmel (May 26), Oregon (June 28), Quincy (June 6), 1928; Catlin (May 17), Effingham (June 18), Jerseyville (June 25), Kansas (June 17), Monticello (May 24), Oakwood (July 22, Oct. 17), Rock Island (July 9), Starved Rock State Park (July 5, Aug. 14), Urbana (May 14, June 7), 1929. All collected on *Prunus avium* and *Prunus persica* except for small specimens taken on *Galium* sp. at Oakwood (Oct. 17), 1929.

MYZUS CIRCUMFLEXUS (BUCKTON)

Siphonophora circumflexa Buckton, Monograph of the British Aphides, Vol. I, 1876, p. 130.

This species, first recorded from the state by Davis (1911), is predominately a greenhouse species. The fact that it is not overly particular as to the host upon which it feeds makes it a species of con-

siderable economic importance. According to Theobald (1926), a sexual reproduction may continue in greenhouses for years without the appearance of the sexual forms, which have not as yet been described. If recent synonymy is correct, and it seems to be, Gillette (1908) has redescribed this species under the name of *Myzus vincae*. The majority of specimens of this species have a horseshoe-shaped brownish area on the dorsum of the abdomen.



Fig. 39. Characteristic grouping of the black cherry aphid, *Myzus cerasi* (Fabricius), on under sides of leaves of new growth on the cherry, *Prunus avium*; Urbana, June 7, 1929.

Data associated with our viviparous specimens are as follows: Evans-ton (May 6), 1927; Carbondale (June 4), Chicago (June 14), Kankakee (June 29), Starved Rock State Park (June 13), 1928; Urbana (Oct. 15), 1929. Collected on *Anchusa myosotidiflora*, *Chrysanthemum*, *Fuchsia* sp., *Geranium* sp., *Ipomoea maxima*, *Lilium* sp., and *Streptocarpus*.

MYZUS ESSIGI GILLETTE & PALMER

Myzus aquilegiae Essig, University of California Publications in Entomology, Vol. I, No. 7, July 20, 1917, p. 314. *Name preoccupied.*

Myzus essigi Gillette & Palmer, Annals of the Entomological Society of America, Vol. XXII, No. 1, March, 1929, p. 30. *New name for aquilegiae* Essig.

We have found this species to be generally distributed throughout Illinois both upon *Aquilegia canadensis* and cultivated varieties of this genus. Since the sexual forms have not been described to our knowledge, their description is presented here.

Our Illinois records for this species are as follows: Havana (June 21), Herod (May 29), Mt. Carmel (May 26), Mt. Carroll (June 25), Oregon (June 27), Starved Rock State Park (June 12), and Urbana (May 23-24), 1928; Urbana (Oct. 15), 1929; Starved Rock State Park (May 13), 1930. Sexual forms were collected at Urbana on October 15.

ALATE MALE

Length from vertex to tip of anal plate, 1.24. Head and thorax dark blackish brown, abdomen dark green with lateral brownish spots, spot posterior to the cornicles largest. Cornicles dusky green, cauda concolorous with abdomen, anal plate brownish green. Antennae dark brown. Femora dark brown with base greenish yellow, fore femora lightest; tibiae and tarsi dark brown. Beak brownish. Genitalia dark brown tipped with black. Veins of wings dark brown.

Average width of head across eyes, .41. Comparative lengths of antennal segments as follows: III— .54, IV— .30, V— .34, VI— .11 plus .63. Secondary sensoria distributed as follows: III— 37, IV— 15, V— 7; scattered over entire third segment, somewhat crowded on one side of fourth segment, arranged in a somewhat irregular row on fifth segment. Beak reaching to mesothoracic coxae. Second fork of media closer to margin of wing than to first fork. Cornicles .23 long, typical for species. Cauda .11 long, very blunt at tip, with two hairs near extreme tip, unlike the cauda of the alate viviparous female.

APTEROUS OVIPAROUS FEMALE

Length from vertex to tip of anal plate, 1.40. Head and thorax light brownish yellow. Abdomen yellow with very minute lateral and dorsal brownish spots. Cornicles yellowish, cauda and anal plate yellowish with some indications of fuscous towards the outer margins. Femora yellowish with some light brown near apex; tibiae yellowish with traces of light fuscous towards apex; tarsi fuscous.

Average width of head across eyes, .39. Comparative lengths of antennal segments as follows: III— .47, IV— .33, V— .17, VI— .10, terminal filament incomplete. Secondary sensoria limited to the third antennal segment, numbering about 7, arranged in a somewhat irregular row. Beak reaching to metathoracic coxae. Cornicles .26 long, cauda .17 long, in shape similar to those of viviparous form.

Allotype.—Alate male; Slide No. 8998, Urbana, Illinois, October 15, 1929, on *Aquilegia* sp. (Frison and Ross). *Morphotype*.—Apterous oviparous female; Slide No. 8999, same data as allotype. On slide with nymphs.

MYZUS HEUCHERAE (THOMAS)

Siphonophora heucherae Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 66.

Thomas described this species from specimens sent to him from Sauk City, Wisconsin, by Professor Bundy. Since that time it has been

reported from California by Davidson—apparently the only record of this species based on actual specimens to be published since the original description was made. This aphid has retained the primitive habit of producing the sexual forms early in the year (May and June) and hence spends the greater portion of the year in the egg stage.

All forms have been described in detail by Davidson (1915). Soliman is certainly correct in placing *heucherae* in the genus *Myzus* (*sens. lat.*) instead of in *Macrosiphum*. Five cotypic slides (Nos. 3174-3175, 7163-7165) of this species are in the Survey collection.

Data associated with our viviparous specimens are as follows: Carbondale (June 4), Herod (May 29), Starved Rock State Park (June 13), 1928. Sexual forms taken at Starved Rock State Park (June 13), 1928. All collected upon *Heuchera* sp.

MYZUS HOUGHTONENSIS (TROOP)

FIGS. 124, 187, 273

Aphis houghtonensis Troop, Entomological News, Vol. XVII, No. 2, February, 1906, p. 59.

The gooseberry witch-broom aphid has been reported from Illinois by Davis (1910), but Baker (1919c) states that this record does not apply to this species. Our material has been compared with cotypic material loaned by the U. S. National Museum. Since other cotypic slides examined by us show a mixing of species, we have selected one slide of the U. S. National Museum material as a *lectotypic* slide. This slide has associated with it the following data: "9919 *houghtonensis* Troop. On gooseberry, LaFayette, Ind., May 20, 1905. J. Troop."

Good technical descriptions of all forms of this aphid are given by Baker (1919). DeLong and Mathewson (1925) have studied its development in relation to temperature and humidity and have come to the conclusion that these factors seem to have a definite effect upon the length of specific generations. According to DeLong and Jones (1926), a strain of plant resistant to attack offers the greatest promise as a method of control.

Data associated with our viviparous specimens are as follows: Havana (June 21), Kankakee (June 29), Oregon (June 27), Pekin (June 20), Rock Island (June 23), 1928; Homer (June 29), 1929; Rock Island (June 3), 1930. All collected on *Ribes Grossularia* and *Ribes* sp.

MYZUS LACTUCAE (SCHRANK)

Aphis lactucae Schrank, Fauna Boica, Vol. II, No. 1233, 1801, p. 120.

This species may have been recorded from Carbondale, Illinois, by Thomas (1879) under the name of "*Siphonophora lactucae* Linn.?" but his identification is questionable. The Davis record (1910) of *Macrosiphum lactucae* Schrank from cultivated lettuce in greenhouses in Illinois is this species. Through the kindness of Professor Davis, we were permitted to study the material upon which his record was based and to incorporate a slide mount in the Survey collection.

Theobald (1926) shows that this species migrates from its overwintering host, *Ribes*, to such plants as lettuce and endive to spend the

summer months. Technical descriptions of the adults are given among others by Davis (1910) and Theobald (1926).

Data associated with the viviparous specimens collected by J. J. Davis are as follows: Chicago (April 23, May 2), Niles Center (Nov. 2), 1908; Chicago (Dec. 1), 1910. All specimens collected on lettuce (*Lactuca*) in greenhouses or on celery (*Apium* sp.) out of doors.

MYZUS MONARDAE (WILLIAMS)

FIG. 86

Phorodon monardae Williams, University Studies, University of Nebraska, Vol. X, No. 2, March, 1911, p. 89.

Rhopalosiphum monardae Williams (Davis), University Studies, University of Nebraska, Vol. XI, No. 3, July, 1911, p. 36.

This species has not been previously recorded from Illinois. We have followed Davis (1911c) in giving Williams credit for the species, although Davis was the first to give a technical description of it. It tightly twists and curls the leaves of its host and is often associated with *Aphis monardae* Oestlund. The sexual forms are unknown.

Data associated with our viviparous specimens are as follows: Carbonale (June 4), Champaign (July 15), Kankakee (June 28, July 15), Pekin (June 20), Rock Island (June 23), 1928; Flora (June 18), Pleasant Plains (May 2), Savanna (July 9), Wayonet (July 6), 1929. Collected on *Monarda fistulosa* and *Monarda* sp.

MYZUS PERSICAE (SULZER)

FIG. 91

Aphis persicae Sulzer, Abgekürzte Geschichte der Insecten nach dem Linnischen System. Winterthur, H. Steiner u. Co., II 2, 1776, p. 105.

The green peach aphid feeds upon a great variety of food plants and is widely distributed throughout the world. It is a potential enemy of considerable economic importance, attacking truck crops, garden flowers, various plants grown in greenhouses, as well as peach trees. Thomas (1879) mentions *Myzus persicae* in such a way that it seems certain his record applies to Illinois specimens, though no definite locality is mentioned. The cotypes of *Rhopalosiphum tulipae* Thomas (Slide No. 7657), from Sauk City, Wisconsin, are this species, as Davis (1910) has stated.

It is not possible to review here the many papers that have been published concerning the control and destructiveness of the green peach aphid. The paper of Weed (1927) is interesting from biological considerations because it demonstrates so well the marked responses of aphids to changes in temperature and humidity. Although this species is definitely known to migrate from peach, plum, and other woody plants (winter hosts) to a great variety of summer hosts, it does produce sexual forms in greenhouses and on some plants commonly referred to as its summer hosts. Good technical descriptions of all forms are to be found in the publications of Gillette (1908b) and Theobald (1926). It is a variable species in color and certain structural characters. The

difference in the cylindrical cornicles of the spring migrant on peach and the somewhat swollen cornicles of the return migrants is rather unusual.

Data associated with our viviparous specimens are as follows: Urbana (Aug. 21), 1885; Urbana (June 20), 1898; Cairo (June 3), Carbondale (May 17, June 4), Champaign (May 23, June 19), Chicago (June 14), Decatur (Sept. 18), DesPlaines (May 20, Aug. 16, Sept. 19, Dec. 18), Herod (Oct. 12), Kankakee (June 29), Quincy (June 6), Shawneetown (May 27), Urbana (May 24, June 4, 6, July 10, 18, Sept. 26, Oct. 1, 19, Dec. 5), 1928; Batchtown (June 25), Catlin (May 17), Collinsville (Sept. 11), DesPlaines (Feb. 9), Effingham (June 18), Grayville (June 19), Kansas (June 17), Kappa (Oct. 3), Macomb (May 4), Melrose Park (Oct. 14), Oregon (July 12), Seymour (Oct. 16), Springfield (May 2), Urbana (May 11, 14, June 4, 21, July 24, Nov. 11, Oct. 9, 15, 21) 1929; Allendale (Oct. 8), Effingham (Nov. 13), Flora (Nov. 13), Urbana (Oct. 4, 13, 20), 1930. Collected on the following plants: *Apium*, *Aquilegia canadensis*, *Arctium* sp., *Asclepias* sp., *Beta vulgaris*, *Brassica oleracea*, *Brassica rapa*, *Brassica* sp., *Capsicum dulce*, *Catalpa speciosa*, *Convolvulus* sp., *Cyclamen* sp., *Dianthus* sp., *Helianthus* sp., *Ipomoea maxima*, *Ligustrum vulgare*, *Lycopersicon esculentum*, *Marsilea quadrifolia*, *Mimulus* sp., *Myosotis*, *Philadelphus coronarius*, *Piqueria trinervia*, *Portulaca oleracea*, *Prunus avium*, *Prunus Persica* (L.) Stokes, *Prunus serotina*, *Radicula Armoracia*, *Raphanus sativus*, *Ribes aureum*, *Salvia leucantha*, *Saxifraga splendens*, *Setaria viridis*, *Solanum melongena*, *Solanum tuberosum*, *Spinacea olivacea*, *Verbena* sp., and *Viola tricolor*.

Sexual forms collected as follows: Seymour (Oct. 16), Urbana (Oct. 21), 1929; Effingham (Nov. 13), Flora (Nov. 13), and Urbana (Oct. 13-20), 1930. Collected on *Ribes* sp., *Prunus avium*, *Prunus domestica*, *Prunus serotina*, and *Rosa* sp.

MYZUS PLANTAGINEUS PASSERINI

Myzus plantagineus Passerini, Gli Afidi, 1860, p. 35.

This species was redescribed and first recorded from North America by Davis (1910), who collected it on plantain at Urbana, LeRoy, and Aurora, Illinois. It has the habit of feeding near the base of the leaves at the crown of the plant and causes the leaves to crinkle and become distorted. Often the colonies are partially covered by "tents" of soil and bits of trash made by ants.

The sexual forms have not been described.

Data associated with our viviparous specimens are as follows: Rock Island (July 7), 1929; Rock Island (June 3), 1930. All collected on *Plantago* sp.

MYZUS POROSUS SANDERSON

FIG. 129

Myzus porosus Sanderson, Twelfth Annual Report of the Delaware College Agricultural Experiment Station, 1901, p. 205.

Because this species has been so rarely mentioned in literature since its description from material collected on strawberry, the writers almost made the mistake of describing as a new species the Illinois material from rose listed below. The fact that our material is *Myzus porosus* Sanderson has been substantiated by a study of cotypic specimens of *porosus*, kindly loaned to us by the United States National Museum. Since the original description of this little known species is very brief, detailed descriptions are presented here.

Miss Patch (1914) has figured the antennae of male and oviparous female specimens collected on *Fragaria* which she considers to be this species. It should be noted that her drawing shows a lack of secondary sensoria on the antennae of oviparous forms, whereas they average about four in number in the specimens from rose which we consider as *porosus*. The original description of the oviparous female, as well as cotypic specimens, reveal a condition similar to that stated in our description. Likewise, the males which we consider to be *porosus* have more sensoria than those considered as this species by Miss Patch. Variation may be responsible for these discrepancies, or we may be dealing with different forms.

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.73 mm. Prothorax and metathorax pale brownish-green; head and especially mesothorax brown, polished; abdomen, including anal plate, green. Cornicles translucent whitish-green, cauda chalky whitish-green. Eyes reddish-brown. Antennae with first two segments and extreme base of third slightly darker than head, remaining portion black. Coxae, trochanters, and basal two-thirds of femora translucent yellowish green; apical third of femora black; tibiae light brown, with a band at apex equal to about twice length of tarsi, black; tarsi black. Stigma and costa yellowish brown; veins and margin of front wing in vicinity of anal vein, black; anal vein and cubitus slightly margined with black. Beak with basal segment concolorous with head, second segment light brown and apex blackish.

Head and appendages.—Average width of head across eyes, .43. Antennal segments with comparative lengths as follows: III— .53 to .89, average .56; IV— .43 to .54, average .48; V— .36 to .46, average .42; VI— .11 to .17, average .13 plus .53 to .66, average .60. Secondary sensoria usually confined to segments three and four, but occasionally the fifth segment has a sensorium; arranged in straight rows; numbering from 14 to 21 and averaging 17 on third segment and from 7 to 8 on fourth segment. Beak extending to the mesothoracic coxae.

Thorax and appendages.—Stigma of fore wings long, narrow and pointed at apex; second fork of media closer to margin of wing than to first fork.

Abdomen.—Certain specimens show evidences of tubercles, but either these tubercles are not always present or they are so poorly developed that only specimens in certain positions show them. Cornicles (Fig. 129) moderately long, straight; base not greatly wider than apex; with a poorly developed rim; about equal in length to twice the length of cauda, ranging in length from .43 to .64 and with an average of .56; not reticulated but imbricated especially at apices. Cauda slightly constricted a little beyond the tip of anal plate, with from one to three hairs on a side, ranging from .23 to .33 and averaging .29 in length. Anal plate rounded at a point to the apex.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 1.84 mm. Head, including first two segments of antennae and base of third, pale greenish brown. Thorax and abdomen green, prothorax shading into the greenish brown of the head. Antennae with segments three, four, and five yellowish-brown with a narrow black ring at apex; sixth segment entirely black. Eyes, legs, cornicles, and cauda as in alate viviparous female.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III— .61 to .71, average .65; IV— .41 to .51, average .45; V— .29 to .40, average .33; VI— .10 to .13, average .12 plus .46 to .53, average .51. Secondary sensoria confined to third antennal segment, almost in a straight line, varying in number from 7 to 10.

Thorax and abdomen.—Except for lack of wings similar to alate viviparous female. Cornicles varying from .54 to .71 and averaging .62 in length, cauda varying from .29 to .33 and averaging .30 in length.

APTEROUS OVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.85. Head light yellowish green, remainder of body a slightly deeper shade of green. Cornicles, cauda, and anal plate yellowish green with a slight brownish stain, cornicles particularly dusky toward apices. Basal portion of antennae concolorous with head, remaining portion gradually shading to brown. Coxae, trochanters, and basal halves of femora concolorous with body; dorsal apical portions of femora brown; fore and middle tibiae yellowish green except for brown apices; hind tibiae with swollen portion and apices brown; all tarsi brown. Beak concolorous with head and body except that apex is brown.

Head and appendages.—Average width of head across eyes, .44. Antennal segments with comparative lengths as follows: III— .47 to .54, average .51; IV— .34 to .40, average .37; V— .29 to .31, average .30; VI— .10 to .11, average .11 plus .43 to .47, average .35. Secondary sensoria restricted to the basal half of the third antennal segment, ranging in number from 2 to 5 and averaging about 4, arranged in a straight row. Beak extending to posterior margins of mesothoracic coxae. Antennal tubercle well developed.

Thorax and appendages.—Tibiae of hind legs considerably swollen where sensoria occur, sensoria numerous, 123 counted on one tibia.

Abdomen and appendages.—Cornicles averaging .62 in length, similar to those of alate viviparous female, not distinctly imbricated. Cauda constricted near middle, with from two to three hairs on a side, averaging .30 in length. Anal plate narrow.

ALATE MALE

Size and general color.—Average length from vertex to tip of anal plate, 1.28. Head and thorax dark greenish brown, abdomen green with lateral and posterior brownish markings. Cornicles, cauda, anal plate, and claspers brownish, particularly claspers. Antennae dark brown, extreme base of third segment lightest. Coxae, trochanters, and bases of femora yellowish green; tibiae with basal and apical portions brown, middle area lighter; tarsi brown. Beak concolorous with head at base and with tip brown. Veins dark, anal vein bordered with fuscous, stigma greyish.

Head and appendages.—Antennal segments with comparative lengths as follows: III— .60 to .64, average .62; IV— .40 to .50, average .45; V— .36 to .39, average .34; VI— .11 plus .59 to .64, average .62. Secondary sensoria located on third, fourth, and fifth segments, and in one specimen on sixth segment, distributed as follows: III— 26 to 33, average 27; IV— 16 to 20, average 18; V— 12 to 18, average 16; VI— 0 to 2. Sensoria on third segment irregularly arranged but confined largely to one side of segment; on fourth and fifth segments they are smaller than on third and confined to one side of segment. Marginal sensoria near primary sensorium on sixth segment apparently lacking. Beak reaching to middle of mesothoracic coxae.

Thorax and appendages.—Stigma of fore wings narrow and comparatively short. Second fork of media closer to margin of wing than first fork.

Abdomen.—Cornicles straight, imbricated throughout length, with a poorly developed flange at apex, averaging .33 in length. Cauda slightly constricted near middle, with from two to three hairs on a side, averaging .18 in length. Claspers dark brown and covered with hairs.

Our specimens, all collected from various forms of *Rosa*, have the following data associated with them: Cairo (June 2), Carbondale (June 4), DesPlaines (in greenhouse, May 20), Kankakee (June 29), Metropolis (June 1), Pekin (June 20), Quincy (June 6), Shawneetown (May 27), and Urbana (May 23-28, July 10), 1928; Cairo (June 22), Collinsville (Sept. 11), Decatur (June 12), Effingham (June 18), Springfield (May 2), and Urbana (Nov. 5), 1929; Decatur (June 10), Effingham (Nov. 13), Maywood (Nov. 3), Metropolis (April 17), Urbana (Nov. 21, Dec. 6, 12), 1930. Sexual forms were collected only on November 5, 1929, at Urbana.

This species, except for antennal tubercles, is suggestive of *Macrosiphum dirhodum* (Walker) which is recorded from the same host. In

the alate form it may be separated from this species by the presence of secondary sensoria on the fourth antennal segment, and from both *Macrosiphum rosae* (L.) and *Macrosiphum pseudorosae* Patch by the fact that the cornicles are not reticulated at the apices. The male is distinguished by the comparatively larger number of sensoria on the fourth segment, and the oviparous female by the presence of secondary sensoria on the third antennal segment. This form belongs to the subgenus *Ncomyzus* Van der Goot and may be the species referred to by Oestlund (1922, p. 139). It can be separated from its close ally, *circumflexus* (Buckton), the type of the subgenus *Ncomyzus*, by the characters given in the key.

MYZUS SCROPHULARIAE (THOMAS)

Phorodon scrophulariae Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 72.

This species has remained virtually unknown since its original description, being referred to only twice in literature since then, once when it was recorded from Berkeley, California, by Clarke (1903) and again when the record of Thomas was mentioned by Davis (1910).

A cotypic slide of *scrophulariae* has been found in the Survey collection (Slide No. 2798, and Thomas' No. 75). It contains two apterous viviparous female specimens of *scrophulariae*, one of which is in good condition, and one specimen not this species. The data associated with this slide are: Carbondale, Illinois, April 13, 1878, on *Scrophularia nodosa*.

The species belongs in the genus *Myzus*, and on the basis of the apterous viviparous female, which is the only form known, keys out with *persicae* and *monardae*.

MYZUS THOMASI new species

FIGS. 261, 264

ALATE VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of anal plate, 1.30. Head and thorax essentially light brown, somewhat greenish on lateral plates and prothorax; abdomen light green. Cornicles, cauda, and anal plate very light dusky brown. Antennae dusky brown, slightly lighter towards the apex and at extreme base of the third segment. Femora yellowish green at base, shading to dusky brown at apex; tibiae light dusky, with extreme apices brown; tarsi light brown. Stigma, costa, subcosta, veins, and posterior margin of wing in vicinity of anal vein, dusky; cubitus and anal vein darkest. Beak dusky, extreme apex dark.

Head and appendages.—Width of head across eyes, .41. Antennal segments with comparative lengths as follows: III— .60; IV— .41; V— .36; VI— .11 plus 1.03. Secondary sensoria (Fig. 261) located on third, fourth, and fifth antennal segments, distributed on unique specimen as follows: III— 38 to 48; average 45; IV— 22 to 23; V— 7 to 12, average 9. Sensoria on all segments more thickly distributed on one side of the segment than on the others; sensoria on the fifth segment in an almost straight row. Hair on antennae short and spine-like, pointing towards apex, not as long as diameter of segment. Beak extending almost to mesothoracic coxae.

Thorax and appendages.—Stigma long and unusually narrow; second fork of media closer to margin of wing than to first fork; tips of medial veins failing to reach margin of wings. Femora with scattered setae very similar to those on antennae; tibiae more strongly armed, especially toward apex; spines strong, numerous, and moderately declinate.

Abdomen.—Cornicles about one-fifth longer than the cauda and one-half as long as third antennal segment; distinctly imbricated throughout; the base distinctly the widest portion, the apex slightly swollen, giving the cornicle a sub-vasiform appearance; the extreme apex slightly constricted and bearing a distinct flange. Cauda with a narrow constriction near the middle, long and comparatively slender, its width only slightly greater than the width of the base of the cornicle, its sides almost parallel, gradually narrowing at apex to a rounded point; apical half with four or five slender scattered hairs. Anal plate normal in shape. Each segment with a pair of small, lateral tubercles. Hairs on body short and sparse.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of anal plate, 1.52. Body, except appendages, light green. First and second antennal segments concolorous with head, remaining segments varying from light greenish-yellow to brown, the brown becoming deeper towards apex. Femora greenish-yellow with their apices slightly infuscated with brown; tibiae light yellowish-brown, concolorous with apices of femora, apices of tibiae darker brown; tarsi brown. Cornicles concolorous with abdomen or slightly infuscate; cauda and anal plate concolorous with abdomen. Beak concolorous with head, slightly dusky at apex.

Head and appendages.—Width of head across eyes, .39. Antennal segments with the following comparative lengths: III— .57 to .59, average .58; IV— .36 to .41, average .39; V— .34; VI— .11 plus .69 to .71, average .70. Secondary sensoria (Fig. 264) present on third, fourth, and fifth antennal segments, distributed as follows: III— 23 to 33, average 27; IV— 5 to 7, average 6; V— 2. Sensoria on the third segment widely scattered, those on fourth arranged almost in a straight row. Beak extends to coxae of meta-thoracic legs.

Abdomen.—Cornicle about one-quarter longer than cauda and about equal to length of fourth antennal segment, similar in general shape to that of alate viviparous female, but more slender and less distinctly imbricated. Cauda slender, constricted near the middle, with two hairs on each side and one at apex. Anal plate normal.

Holotype.—Alate viviparous female; Rock Island, Illinois, July 9, 1929, on *Ribes* sp., (Frison and Hottes). On slide with nymphs, and specimens of *Aphis sanborni* Patch. Slide No. 10705. *Morphotype*.—Apterous viviparous female; same data as holotype. On slide with pupae and specimens of *Aphis sanborni* Patch. Slide No. 10706. *Paratype*.—One slide containing an apterous viviparous female and pupae, and specimens of *Aphis sanborni* Patch. Same data as holotype. Slide No. 10707.

This species may be readily separated from other species of the genus *Myzus* by the characters given in the key. The aggregate of characters of this species is such that it seems advisable to erect a new subgenus for it, *Myzus houghtonensis* (Troop), and *Myzus heucherae* (Thomas), for which we propose the name of *Kakimia*. The characterization of this new subgenus is as follows:

KAKIMIA new subgenus

Antennal tubercles poorly developed. Antennae with six segments, with numerous large round sensoria on the third, fourth, and often the fifth segments. Fore wings with media twice-branched, hind wings with both media and cubitus present. Anal plate rounded. Cornicles with base the widest portion, apex slightly swollen, thus giving cornicles a sub-vasiform appearance; apex with distinct flange. Cauda with narrow constriction near middle, long and comparatively slender, narrowing at apex to a rounded point.

Type of subgenus.—*Myzus (Kakimia) thomasi* new species.

GENUS PENTALONIA COQUEREL

PENTALONIA NIGRONERVOSA COQUEREL

FIGS. 74, 95

Pentalonia nigronervosa Coquerel, Annales Societé Entomologique de France, Ser. 3, 1859, Vol. VII, p. 259.

This species is here reported from Illinois for the first time. In this state it is a greenhouse species and undoubtedly an importation from tropical climates. Zeck and Eastwood (1929) have shown that this insect not only causes direct damage by sucking sap of the banana, but is a carrier of the virus of "bunchy top" of Manila hemp in the Philippines. Good descriptions of the viviparous forms are given by Theobald (1926).

Data associated with our viviparous specimens of this peculiar aphid are as follows: Garfield Park Conservatory, Chicago, June 14, 1928, on *Hedychium coronarium*.

GENUS PHORODON PASSERINI

PHORODON HUMULI (SCHRANK)

FIG. 85

Aphis humuli Schrank, Fauna Boica, Band 2, 1 Abt., 1801, p. 110.

The hop aphid was included by Thomas (1879) in his Third Annual Report, though without definite mention of his having collected it in Illinois. It is not included in the more recent list of Davis (1910). For a long time it has been known as a serious pest of hops both in Europe and America. It is easily recognized because of the peculiar shape of the antennal tubercles (Fig. 85).

The winter is passed in the egg stage on plum. After a few generations on this host the aphids then migrate to hop for numerous summer generations. The sexual forms are produced in fall, the oviparous females being produced exclusively on the over-wintering host. The bulletin by Parker (1913) gives a good general account of this aphid in the Pacific Coast Region of North America. Another good general account, together with technical descriptions of all forms, is presented by Theobald (1926).

Data associated with our viviparous specimens are as follows: Muncie (July 8), Urbana (July 10), 1928; Gays (Sept. 10), Kappa (Sept. 10, 22, Oct. 1), Rock Island (July 7), 1929; Aledo (June 4), 1930. All collected on hop, *Humulus Lupulus*.

SUBFAMILY ERIOSOMATINAE

SUPERTRIBE ERIOSOMEA

Key to Genera

- | | |
|-------------------------------------|---|
| 1. Antennae with five segments..... | 2 |
| — Antennae with six segments..... | 4 |

2. Antennae with conspicuous setae; secondary sensoria oval or transverse-oval; stigma of fore wing rounded at apex, posterior margin convex (Fig. 69); wholly subterranean forms, not living in galls.....3
- Antennae without conspicuous setae; secondary sensoria more narrow and annular; stigma of fore wings pointed at apex, posterior margin concave (Fig. 73); living in galls on leaves of sumac *Melaphis* p. 359
3. Third antennal segment with not more than ten secondary sensoria; apterous forms with conspicuous and peculiarly bent and enlarged setae (Fig. 318)..... *Geioica* p. 356
- Third antennal segment with twenty or more secondary sensoria; apterous forms without bent and enlarged setae..... *Forda* p. 354
4. Third antennal segment with narrow annular, transverse, or ring-like secondary sensoria, giving antennae a corrugated or notched appearance when viewed from the side (Fig. 223).....5
- Third antennal segment with oval or oval-transverse secondary sensoria, not annular, giving antennae a more even or cylindrical appearance when viewed from the side (Fig. 238).....16
5. Fore wings normally with medial vein branched (Fig. 69).....6
- Fore wings normally with medial vein not branched (Fig. 64).....9
6. Fourth antennal segment about twice as long as greatest width.....7
- Fourth antennal segment three or four times as long as greatest width8
7. Hind wings with only medius present (Fig. 88); annular sensoria numbering about ten on third segment, and usually not more than three each on fourth, fifth, or sixth segments; aerial forms producing cockscomb galls (Fig. 41) on elms...
..... *Colopha (Colopha)* p. 348
- Hind wings with both medius and cubitus present (Fig. 92); annular sensoria numbering about eighteen on third segment, and usually five or more on fourth, fifth or sixth segments; producing bag-like galls (Fig. 46) on elms..... *Gobaishia* p. 359
8. Annular secondary sensoria incomplete or rarely entirely encircling antennal segments, well separated from one another on third segment (Fig. 226); curling leaves of elm (Fig. 45)..
..... *Georgiaphis* p. 357
- Annular secondary sensoria of antennae complete, almost or entirely encircling antennal segments; closely paralleling one another on third segment (Fig. 225); stem, bark, root or leaf feeders *Eriosoma* p. 350
9. Terminal filament of sixth antennal segment much longer than basal portion (Fig. 239) [Fundatrigenia or spring migrants leaving galls]; producing irregular sponge-like gall (Fig. 47) on poplar *Mordwilkoja* p. 360
- Terminal filament of sixth antennal segment not longer than basal portion10
10. Hind wings with only medius present (Fig. 88).....11
- Hind wings with both medius and cubitus present (Fig. 87).....12
11. Fourth antennal segment not more than twice as long as greatest width; aerial forms producing cockscomb galls (Fig. 41) on elms *Colopha (Colophella)* p. 348
- Fourth antennal segment about four times as long as greatest width; curling leaves of elms (Fig. 45)..... *Georgiaphis* p. 357
12. Longitudinal vein of hind wing not straight, with radial sector, media, and cubitus arising in a more or less three-pronged fork (Fig. 94)13
- Longitudinal vein almost straight, media and cubitus originating far apart and running subparallel to one another (Fig. 87).....15

13. Dorsum of head between compound eyes with two conspicuous large wax-pore plates [Sexuparae or fall migrants returning to galls] *Mordwilkoja* p. 360
- Dorsum of head between compound eyes without conspicuous large wax-pore plates 14
14. Fourth antennal segment about twice as long as greatest width; antennae of stem mother four-segmented *Pemphigus* p. 363
- Fourth antennal segment about four times as long as greatest width; antennae of stem mother five-segmented *Thecabius* p. 374
15. Stigma of fore wings pointed at apex, its posterior margin concave (Fig. 73); living in pear-shaped or round galls on leaves of sumac *Melaphis* p. 359
- Stigma of fore wings more rounded at apex, its postero-apical margin convex (Fig. 69); living in bag-like galls (Fig. 46) on leaves of elm *Gobaishia* p. 359
16. Antennae with numerous conspicuous hairs; species strictly subterranean, living continuously as far as known on roots of plants 17
- Antennae without hairs or with only a few minute ones; species not subterranean or but partially so, living mostly in pseudo-galls or in dense colonies on branches and leaves 18
17. Sixth antennal segment much longer than fifth; apterous forms with simple setae *Trifidaphis* p. 374
- Sixth antennal segment approximately as long as fifth; apterous forms with peculiarly bent and enlarged setae (Fig. 318) *Geioica* p. 356
18. Fourth antennal segment comparatively short, about one-half (or less) as long as third, usually shorter than basal portion of sixth antennal segment, its length not exceeding five times its greatest width 19
- Fourth antennal segment comparatively long, two-thirds (or more) as long as third, sometimes about as long as basal portion of sixth antennal segment, its length at least eight times its greatest width *Neoprociphilus* p. 361
19. Sixth antennal segment (basal portion plus terminal filament) as long as, or longer than, the fifth; never on elms 20
- Sixth antennal segment (basal portion plus terminal filament) shorter than the fifth; living in curled leaves (Fig. 45) on elms *Georgiaphis* p. 357
20. Fore tibia but slightly longer than width of head through eyes; media of fore wings usually branched but occasionally simple *Asiphum* p. 348
- Fore tibia longer, usually much longer than width of head through eyes; media of fore wings simple 21
21. Distance between wax-pore plates (Fig. 329) of mesonotum subequal to half the greatest diameter of one of them, except *P. imbricator*, in which the stigma is narrow, long, and pointed at apex (Fig. 97); stem mother [fundatrix] with five-segmented antennae; species with aerial forms causing pseudo-galls (Fig. 50), curling leaves, or living in dense colonies and not frequenting poplars *Prociphilus* p. 370
- Wax-pore plates (Fig. 330) of mesonotum separated by more than half the greatest diameter of one of them; stigma short and broad and diagonally truncate at apex (Fig. 98); stem mother [fundatrix] with four segmented antennae; species with aerial forms forming true galls (Fig. 49) and restricted to poplars *Pemphigus* p. 363

GENUS ASIPHUM KOCH

ASIPHUM PSEUDOBYSRA (WALSH)

Byrsocrypta pseudobysra Walsh, Proceedings of the Entomological Society of Philadelphia, December, 1862, p. 306.

This species has not been reported from Illinois since it was first described by Walsh (1862) from material taken near Rock Island. It seems probable that this aphid has an alternate host, because the alate forms leave the poplars in spring or early summer. Figures showing structural details and general appearance of adults, as well as appearance of infested leaves, have been published by Gillette (1911), who has also given the best descriptions of the known forms and data concerning their biology. He states: "The young lice all leave the stem-mother gall, which is a small almond-shaped pocket about midway on the midrib of the leaf, very soon after being born, and locate on the under or ventral surface. The larvae locate along the main veins into which they insert their beaks and their bodies soon become snowy white with a dense covering of short wax threads.....All of the second generation lice become winged."

According to statements in literature the media of the fore wings is branched, but our Illinois material shows that the media may sometimes be simple, or not branched. The determination of our specimens has been checked by Mr. A. C. Maxson.

Data associated with our specimens, all collected on *Populus*, are as follows: Galena (June 26), Oakwood (July 18), 1928. There is an alate specimen in the J. J. Davis collection from Chicago, Illinois, August 13, 1908, which is evidently a migrant or drift collected on *Pinus*.

GENUS COLOPHA MONELL

(SUBGENERA COLOPHA MONELL AND COLOPHELLA BÖRNER)

Key to the Species of the Genus Colopha

1. Fore wings with medial vein branched (Fig. 69).....*ulmicola* (Fitch) p. 349
- . Fore wings with medial vein not branched (Fig. 64).....*graminis* (Monell) p. 348

COLOPHA GRAMINIS (MONELL)

FIGS. 40, 64, 88

Tetraneura graminis Monell, Canadian Entomologist, Vol. XIV, No. 1, January, 1882, p. 16.

Rhizobius spicatus Hart, Eighteenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. (Text by S. A. Forbes, descriptions by C. A. Hart). March, 1895, p. 104.

This species and the following one is responsible for the curious cockscomb-like galls so common in spring on the upper surface of leaves of elms (Fig. 40). They migrate between elms and the roots of

grasses, the latter being the summer host. *Rhizobius spicatus* Hart (1895) has been placed by Cutright (1925) as the root form of this species, or *Colopha ulmicola* (Fitch), and we have accepted this synonymy. Certainly, *R. spicatus* Hart is the root form of some aerial form common in Illinois, and the cotypes agree in general with the illustrations of the root forms of *graminis* and *ulmicola* given by Patch (1910a). The best summary of the characters and habits of this small aphid is given by Patch (1910a).

Börner (1926) placed this species in the genus *Colophella* and later (1930) reduced *Colophella* to subgeneric rank. We are considering *Colophella* as a subgeneric name, pending the solution of the exact relationship between the species under discussion here and *Colopha ulmicola* (Fitch). As mentioned under the discussion of the latter, we may be dealing with a dimorphic form and hence a single genus. Reducing *Colophella* to subgeneric status may be only a temporary shift, but it will not mislead others into thinking the problem has been solved as the complete abandonment of name *Colophella* (*Tetraneura* authors) might do.

Data associated with our specimens, all taken on elms (*Ulmus fulva* and *americana*), are as follows: Normal (June 30), 1884; Mt. Carroll (June 25), Oregon (June 28), 1928; Hardin (June 25), Homer (June 17), Jonesboro (June 23), Newton (June 17), 1929. The data associated with cotypic specimens of *R. spicatus*, all in poor condition, are as follows: Urbana (April 10 and July 20), 1886, on roots of corn, slides 7653 and 7654; and Tamaroa (Oct. 5), 1893, on roots of corn, slides 7655 and 7656.

COLOPHA ULMICOLA (FITCH)

FIGS. 40, 69

Byrsocrypta ulmicola Fitch, Transactions of the New York State Agricultural Society, Vol. XVIII, 1858 (printed 1859), p. 843.

Like *Colopha* (*Colophella*) *graminis* (Monell), this species produces cockscomb-like galls on the upper surfaces of elm leaves (Fig. 40). These two species can be separated only upon the basis of wing venation, and Patch (1910a) has found some evidence that one may be a dimorphic form of the other. Our present information, however, is too incomplete to permit considering them here as the same species. *C. ulmicola* (Fitch) has been previously recorded from Illinois by Walsh (1862), Middleton (1878), Thomas (1879), Patch (1910a), and Davis (1910d). *Colopha cragrostidis* Middleton (1878), evidently described from Illinois material, has been placed in the synonymy of *C. ulmicola* by several authors, and this is undoubtedly correct.

Data associated with our specimens, all from elms (*Ulmus fulva* and *U. americana*), are as follows: Anna (April 11), 1884; Antioch (June 15), Cave-in-Rock (May 30), Kankakee (June 29), Oakwood (July 8), Starved Rock State Park (June 13), Urbana (July 10), 1928; Oakwood (June 29), Rock Island (July 7), Starved Rock State Park (July 5), Waukegan (July 13), 1929.



Fig. 40. Cockscomb galls on upper surfaces of leaves of the white elm, *Ulmus americana*, caused by *Colopha ulmicola* (Fitch); Oakwood, June 29, 1929. A similar gall is caused by *Colopha graminis* (Monell).

GENUS ERIOSOMA LEACH

Key to the Species of the Genus *Eriosoma*

1. Fifth antennal segment (Fig. 223) usually without well-developed annular secondary sensoria; curling leaves of elm.....
..... *mimica* n. sp. p. 353
- Fifth antennal segment usually with well-developed annular secondary sensoria; curling leaves of elm or closely clustered on branches (Fig. 42), leaves, or bark (Fig. 43) of elm, apple, and hawthorn 2
2. Sixth antennal segment usually without annular secondary sensoria; causing a leaf cluster or rosette on terminal twigs of elms, [fundatrigenia]..... *lanigera* (Hausmann) p. 351
- Sixth antennal segment usually with annular secondary sensoria; never causing a leaf cluster; on roots, twigs, or branches, rarely leaves..... 3
3. Medial vein of fore wing with point of origin of fork much beyond, or distad of, point of origin of radial sector; forming flocculent colonies on trunk and branches of elms (Fig. 43).....
..... *rileyi* Thomas p. 354
- Medial vein of fore wing with point of origin little, if any, beyond point of origin of radial sector; forming flocculent colonies on trunks, branches, or roots of apple or hawthorn (Fig. 42) 4

4. Lining lower sides of branches of hawthorn in dense flocculent colonies (Fig. 42); waxy secretion granular; fourth antennal segment with from six to nine annular secondary sensoria; fifth segment with from five to nine annular secondary sensoria *crataegi* (Oestlund) p. 351
- On bark, roots, branches, and leaves of apple; waxy secretion consisting of long fine wavy whitish filaments; fourth antennal segment with from three to five annular secondary sensoria; fifth segment with from four to six annular secondary sensoria [sexuparae] *lanigera* (Hausmann) p. 351

ERIOSOMA CRATAEGI (OESTLUND)

FIGS. 41, 92

Schizoneura crataegi Oestlund, Geological and Natural History Survey of Minnesota, Bulletin No. 4, 1887, p. 27.

This species was first reported from Illinois by Davis (1910d), who considered it a "serious pest of hawthorns used in ornamental plantings in Chicago." It has been very abundant on certain *Crataegus* plantings on the University campus at Urbana for the last three years. The lower sides of most branches of these shrubs were lined with a solid mass of aphids, made particularly conspicuous by the large quantity of white flocculent secretion produced (Fig. 41). The life history is not well known, and the species has at times been thought to be the same as *E. lanigerum* (Hausmann)—a view which we think has not been substantiated. The flocculent secretion of *E. lanigerum* is in long, silken, fluffy threads and often a bluish white, whereas in this species the flocculent secretion is more granular, compact, and chalky white in color.

Records associated with specimens of this species, all taken on *Crataegus* sp., are as follows: Odin (Aug. 27), 1888; Catlin (Sept. 27), Urbana (Aug. 2, Sept. 26), 1928; Muncie (Sept. 22), Oakwood (July 22), Starved Rock State Park (July 6), 1929; Chicago (Sept. 20).

ERIOSOMA LANIGERA (HAUSMANN)

FIGS. 158, 221, 225

Aphis lanigera Hausmann, Illiger's "Magazin für Insektenkunde," Vol. I, Braunschweig, 1802, p. 440.

Thomas first reported the woolly apple aphid from Illinois in 1877 under the generic name of *Eriosoma* and later (1879) under *Schizoneura*. It is common in all parts of the state and often is responsible for severe injury to young apple trees. The important discovery that this species migrates to apple in spring and early summer from leaf clusters or leaf rosettes on elm was first brought to general attention by Patch (1912), whose observations have since been confirmed by numerous studies by others. The paper by Baker (1915) presents a very thorough biological and morphological study of this pest.

Data associated with our specimens, all collected from leaf rosettes on elm (*Ulmus*) or bark and twigs of apple (*Pyrus*), are as follows: Antioch (June 15), Cave-in-Rock (May 30), Danville (July 15), Golconda (May 31),



Fig. 41. Characteristic groupings of adults and nymphs of *Eriosoma crataegi* (Oestlund) on hawthorn, *Crataegus*; Urbana, October 2, 1929. Production of large quantities of a white wax secretion makes them very conspicuous

Metropolis (June 1), Oakwood (May 29), Quincy (June 6), Shawneetown (May 27), Starved Rock State Park (June 12), 1928; Decatur (June 12), Elizabethtown (June 20), Hardin (June 25), Newton (June 17), Starved Rock State Park (July 5), 1929; Metropolis (April 17), 1930.

ERIOSOMA MIMICA new species

FIG. 223

ALATE VIVIPAROUS FEMALE

Size and general color.—Average length from vertex to tip of cauda, 1.49. Head and thorax dark dusky brown, abdomen yellowish brown. Cornicles dark brown. Antennae, legs, and beak yellowish brown, considerably lighter in color than head. Stigma of fore wings light dusky, veins the same. Head, thorax, and abdomen lightly pulverulent.

Head and appendages.—Average width of head across eyes, .31. Antennal segments with comparative lengths as follows: III— .23 to .29, average .25; IV— .07 to .10, average .09; V— .07 to .09, average .09; VI— .07 to .09, average .08. Secondary sensoria (Fig. 223) annular and distributed as follows: III— 17 to 24, average 19; IV— 4 to 6, average 5; V— 0 to one; VI— 0 to 1. Fifth and sixth antennal segments without secondary sensoria except sometimes at extreme tips of segments. Primary sensorium on fifth antennal segment annular and sometimes cleft; sensorium on sixth segment ovoid, normal. Beak reaching to mesothoracic coxae.

Thorax and appendages.—Mesothorax with a pair of large, oval wax glands on ventral portion of pleurae. Fore wings with stigma comparatively short and blunt and with radial sector comparatively straight. Hind tibiae .63 in length.

Abdomen.—Cornicles very shallow, ring-like. Anal plate not much wider than the cauda, which extends barely beyond the tip of the abdomen. Wax-pore plates on the abdomen indistinguishable in our preparations.

APTEROUS VIVIPAROUS FEMALE

Size and general color.—Length from vertex to tip of cauda, 1.73. Head, thorax and abdomen uniformly yellowish brown. Antennae slightly lighter than body with fifth and sixth segment slightly darker. Legs slightly darker than body, with the coxae and femora slightly darker than the tibiae and tarsi. Beak yellowish brown with the extreme tip darkest.

Head and appendages.—Average width of head across eyes, .40. Antennal segments with the following comparative lengths: III— .24; IV— .10; V— .09; VI— .09. Apparently both primary and secondary sensoria are absent. Antennae almost smooth, only slightly wrinkled, with a few scattered, fine hairs.

Thorax and abdomen.—Pro-, meso-, and metathoracic segments with large ovate wax-pore plates on the lateral margins. Abdomen with five pairs of wax-pore plates on the lateral margins anterior to cornicles similar to those found on thorax; posterior to cornicles are two very large wax-pore plates which extend across the posterior portion of the abdomen as two transverse bands, one just anterior to base of cauda, the other extending along the extreme posterior portion of the abdomen. Cauda not extending beyond tip of abdomen. Anal plate a little broader than cauda.

Holotype.—Alate viviparous female; Mt. Carroll, Illinois, June 25, 1928, on *Ulmus fulva*, (Frison and Hottes). On slide with paratypic apterous and alate viviparous females and pupa. Slide No. 5538. *Morphotype.*—Apterous viviparous female; same data as holotype. Slide No. 5539. *Paratypes.*—Five slides, containing alate and apterous viviparous females and pupae, collected in Illinois on *Ulmus fulva*, by T. H. Frison and F. C. Hottes, at Mt. Carroll, June 25, and Kankakee, June 29, 1928. Slides Nos. 5537, 5540-5542 and one other unnumbered.

This species resembles *E. ulmi* (Linnaeus) in the reduced number, or entire lack, of secondary sensoria on the fifth and sixth antennal segments. It differs from the spring migrants of that species, as figured by

Patch (1913b) and Theobald (1929), in having much shorter antennae, about one-half as many secondary sensoria on the third antennal segment, and the third antennal segment not conspicuously exceeding the combined length of the fourth, fifth, and sixth segments. This species was declared to be new by Mr. A. C. Maxson to whom it was sent questionably determined as *ulmi*. We have no exact information as to the gall from which this species came, but we believe it caused a curling of the leaf of its host, the red elm (*Ulmus fulva*).

ERIOSOMA RILEYI THOMAS

FIG. 42

Eriosoma ulmi Riley, First Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri, 1869, p. 123. *Name preoccupied.*
Eriosoma rileyi Thomas, Transactions of the Illinois State Horticultural Society, Vol. X, new series, 1876 (1877), p. 191. *New name. Spelling of Riley a lapsus calami.*

This species was originally described by Riley (1869) under the name of *Eriosoma ulmi*. Thomas (1877), recognizing that the specific name for this distinct species was preoccupied by *ulmi* Linnaeus, gave it the new name of *rileyi*. Through a typographical error the name was first spelled as *Rilepi*, but this is an evident *lapsus calami* because Thomas stated that he "named it after the original describer" and subsequently (1879) spelled the name as *rileyi*. It is a bark-feeding species (Fig. 42) and at times has been considered as a form of *E. lanigera* (Hausmann). The studies of Patch (1913b) indicate it passes its entire life cycle on elm and is a distinct species. Mordvilko (1924) states, "All living *Eriosomea* are inevitably attached to *Ulmus*, which means that they made their appearance and performed their evolution together with *Ulmus*, having originally been monophagous, as for instance the living *Eriosoma rileyi* Thomas in North America or *E. patchiae* Börner in the Mediterranean region."

Data associated with our specimens, all collected on the red or slippery elm (*Ulmus fulva*), are as follows: Champaign (June 8), Urbana (Oct. 22), 1928; Urbana (July 2), 1929.

GENUS FORDA HEYDEN

The American forms of this genus are not known to form galls and apparently live a wholly subterranean existence. Mordvilko (1928a) has shown, however, that *Forda trivalis* in Eurasia may develop in galls on leaves of *Pistacia*.

Key to the Species of the Genus Forda

1. Antennae of alate female with third segment much longer than length of fourth and fifth segments together, with about thirty secondary sensoria; apterous forms with numerous setae about as long as width of third antennal segment. *occidentalis* Hart p. 356
- Antennae of alate female with third scarcely longer than length of fourth and fifth segments together, with about twenty-four or less secondary sensoria; apterous forms with a few setae much less in length than width of third antennal segment. *olivacea* Rohwer p. 356

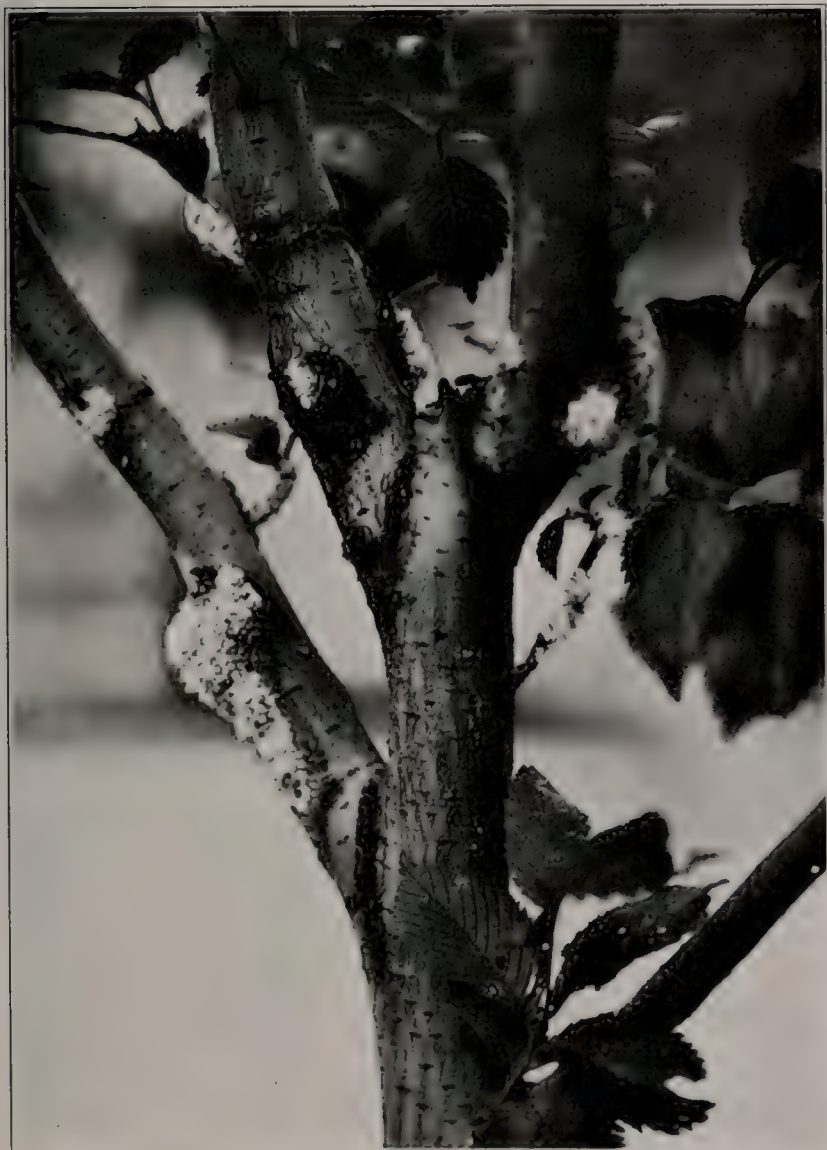


Fig. 42. Adults and nymphs of *Eriosoma rileyi* Thomas on the slippery elm, *Ulmus fulva*: Urbana, July 2, 1929. Clusters of the aphids most abundant at scars where branches were pruned.

FORDA OCCIDENTALIS HART

Forda occidentalis Hart, Eighteenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, Springfield, March 4, 1895, p. 85.

Hart described this species from specimens collected in Illinois on the roots of shepherd's-purse (*Capsella Bursa-pastoris*), blue-grass, and corn. Only a few specimens of the original typic material remain and these are in very poor condition but still indicate the generic affinities of the species and show that it has setiferous antennae in the apterous forms. Gillette (1918) has placed this species in the synonymy of *F. formicaria* Heyden, but Theobald (1929) says this is in error. Maxson states in a letter to us that this species is unknown to him and comes nearest to *formicaria* Heyden. According to the observations of Hart (1895) and Gillette (1918), this species apparently passes its entire life cycle on the roots of grasses and is usually attended by ants.

Data associated with specimens in the Survey collection are as follows: Champaign (April 28—*lectotypic* slide, No. 7650), Urbana (April 4—*paratypic* slide, No. 7652, and April 10—*paratypic* slides, Nos. 7651 and 3170), 1894.

FORDA OLIVACEA ROHWER

Forda olivacea Rohwer, Psyche, Vol. XV, August, 1908, p. 68.

This species is recorded from Illinois for the first time. Our specimens were determined by Mr. A. C. Maxson. Most of the information that is available concerning the biology of this root-feeding species is contained in the article by Gillette (1918).

Data associated with our specimens are as follows: Danville (Sept. 18), Logan County (May 16), Oakwood (May 16), Urbana (June 10), 1928; Urbana, Brownfield woods (March 25), 1929. Collected on roots of grass, oats, and wheat.

GENUS GEOICA HART

GEOICA SQUAMOSA HART

FIGS. 43, 317, 318

Geoica squamosa Hart, Eighteenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, Springfield, March 4, 1895, p. 102.

This root-feeding species (Fig. 43), originally described from Illinois material, is readily determined by its peculiar setae, which are bent and enlarged (Figs. 317, 318). Hart (1895) gives the best account of its habits. He found it often attended by ants. He reported it as a minor pest of corn and also recorded it from the roots of grasses, weeds, and clover. Apparently its entire active life cycle is spent on the roots of its various hosts, the eggs being kept by ants during the winter.

Mordvilko (1928a) described the genus *Pemphigetum*, with *muticae* Mordvilko as type, from material collected in Turkestan on *Pistacia*.

Later in the same year Mordvilko sunk *Pemphigietum* as a synonym of *Geoica* Hart and stated that *squamosa* Hart is a synonym of *utricularia* (Pass.). In view of the number of species of *Geoica* recognized by Theobald (1929), and the possibility of *squamosa* not being synonymous with *utricularia*, we are retaining the name of the former. If *squamosa* and *utricularia* are synonymous, then the former is certainly anolocyclic in North America.



Fig. 43. Apterous viviparous female of a subterranean plant louse, *Geoica squamosa* Hart. (After Forbes and Hart: Ill. Ent. Rep. 18.)

Data associated with our specimens, mostly belonging to the typic series, are as follows: Normal (June 1, 6, Nov. 24), 1883; Normal (April 1, June 13, July 28, Nov. 19), 1884; Urbana (May 25, July 14, Aug. 11), 1885; Champaign (Feb. 26, Oct. 28), Normal (May 21), Urbana (May 21, 24, 29, Oct. 28), 1886; Champaign (April 19, Oct. 20), Urbana (May 7, 19, 31, June 1), 1887; Champaign (May 19), Urbana (May 9), 1888; Urbana (Nov. 24), 1890; Urbana (March 26), 1892; Champaign (April 26), Normal (April 1), Urbana (March 21, 23, April 4, 10, 12, May 12-14), 1894; Urbana (September 16), 1898; Buda (May 28), Oneida (May 27), 1901; Clayton (June 21), 1929; Humboldt (Nov. 12), 1930. The lectotypic slide is number 3164 (Frison, 1927). Paratype slide numbers are as follows: 3161-3169, 3172-3173, and 7661-7675.

GENUS GEORGIAPHIS MAXSON AND HOTTES

GEORGIAPHIS ULMI (WILSON)

FIGS. 44, 226

Georgia ulmi Wilson, Canadian Entomologist, Vol. XLIII, No. 2, February, 1911, p. 64.

Georgia gillettei Maxson and Hottes, Entomological News, Vol. XXXVII, No. 5, May, 1926, p. 130. *New synonymy.*

This species, not previously recorded from Illinois, has been taken from various localities over the entire state. It produces a leaf-curl (Fig. 44) on slippery elm (*Ulmus fulva*), which is similar to that of *Eriosoma americana* Riley. On certain trees in Urbana, *Georgiaphis*

ulmi produces a very heavy infestation every year, and has in the course of time markedly stunted their growth and sapped their vitality. At the time of the production of the sexual forms, some of these heavily infested trees produce so many winged lice that large piles of them accumulate under the trees. This species has been taken only on *Ulmus fulva* and *Ulmus alata*, and our records indicate that the entire life cycle is passed on the one host.

A large series of specimens shows that this species is very variable in regard to certain structural characters which have been used in the past to separate *G. ulmi* and *G. gillettei*. In fact, there is such great variation that we believe that in Illinois there is only one good



Fig. 44. An elm leaf curl caused by *Georgiaphis ulmi* (Wilson) on the slippery elm, *Ulmus fulva*; Urbana, June 10, 1929.

species in the genus, and that *gillettei* is only a variation of *ulmi*. Mr. A. C. Maxson has studied our material and says in correspondence on the matter: "I am beginning to fear that there is but one species of *Georgiaphis*, in which case *gillettei* would become of synonym of *ulmi*."

Records of this species in our collection are as follows: Urbana (June 14), 1885; Berwyn (June 15), Carbondale (June 4), East Dubuque (June 25), Herod (May 29), Mt. Carmel (May 26), Oakwood (June 17), Oregon (June 27), Pekin (June 20), Urbana (May 22, June 11 and 14), 1928; Urbana (June 4 and 11), 1929. Sexual forms have been taken at Urbana during the first two weeks of June.

GENUS GOBAISHIA MATSUMURA

GOBAISHIA ULMI-FUSUS (WALSH AND RILEY)

FIG. 45, 87

Pemphigus ulmi-fusus Walsh and Riley, American Entomologist, Vol. I, No. 6, February, 1869, p. 109.

This species was originally described from New York and "South Illinois" in a foot-note by Walsh and Riley (1869). Since then it has been recorded again from LeRoy and Urbana, Illinois, by Davis (1910d), and by Gronemann (1930) from the Chicago area (actual



Fig. 45. Pouch-like gall of *Gobaisha ulmi-fusus* (Walsh) on upper surfaces of leaves of the slippery elm, *Ulmus fulva*; Jonesboro, June 23, 1929.

specimens from Elgin). The large conspicuous bag-like gall (Fig. 45) is found on the upper side of the leaf of the slippery or red elm. The best account of this insect, together with descriptions and figures of structural details of adults, is that given by Patch (1910a).

The data associated with our Illinois specimens, all collected on *Ulmus fulva*, are as follows: Urbana (June 27), 1887; Tonti (June 12), 1888; Elgin (June 23), 1925; Jonesboro (June 23), 1929.

GENUS MELAPHIS WALSH

MELAPHIS RHOIS (FITCH)

FIG. 73

Byrsocrypta rhois Fitch, Journal New York Agricultural Society, Vol. XVI, August, 1866, p. 73.

This species, rare in Illinois, causes a small sac-like gall on the upper surface of the leaves of sumach (*Rhus* sp.). It was included among the species listed by Thomas (1879) but was not definitely recorded by him from Illinois. Walsh (1869) mentions this species

as occurring both in "Illinois and New York." Baker (1919a) has described a *Mcclaphis*, called *minutus*, collected on moss, May 5, 1916, at Springfield, West Virginia, and suggests that there is a remote possibility of his *minutus* being the spring forms of *rhois*.

This species was not taken by us during our work of the past three years, but there are specimens in the Survey collection which were found on sumach (*Rhus*) at Milan, Illinois, August 16, 1885.

GENUS MORDWILKOJA DEL GUERCIO

MORDWILKOJA VAGABUNDA (WALSH)

FIG. 46

Byrsocrypta vagabunda Walsh. Proceedings of the Entomological Society. of Philadelphia, Vol. I, December, 1862, p. 306.

This species was originally described by Walsh from fall migrants collected at Rock Island, Illinois. The galls caused by this plant louse are large, irregular, bladder-like growths (Fig. 46) on the terminal twigs of poplars. The life history of this migratory aphid is particularly interesting because the sexuparae, or fall migrants, have been



Fig. 46. A curious malformation of buds of the poplar, *Populus deltoides*, caused by a plant louse, *Mordwilkoja vagabunda* (Walsh); Savanna, July 9, 1929.

shown by Oestlund and Hottes (1926) to return from an unknown summer host to the galls formed on poplars by their ancestors in spring or early summer, i. e., by forms which preceded them by three to six generations. The finding of the return fall migrants, as well as sexual forms and eggs, in old galls on poplars at Willow Springs, Illinois, on November 5, 1930, shows that in Illinois the life history of this species is identical with that as described by Oestlund and Hottes (1926) for Minnesota. The summer host is still unknown.

In view of the fact that this species was originally described from fall migrants from Illinois by Walsh, and the types are lost, Slide No. 9744 of fall migrants in the collection of the Illinois State Natural History Survey has been selected as the *neotypic* slide.

Data associated with our Illinois specimens, all collected on *Populus deltoides*, are as follows: Urbana (July 14), 1885; Shawneetown (June 26), 1909; Beach (June 17-galls), 1928; Beach (July 13), Savanna (July 9), 1929; Charleston (December 14-galls), DesPlaines (July 10-galls), East Peoria (December 3-galls), Palos Park (Feb. 11-galls and eggs), Willow Springs (Nov. 5-galls, sexuparae, sexual forms, and eggs), 1930; Atlanta (Feb. 24), Bondville (Jan. 28-galls), Decatur (Jan. 28-galls), Funks Grove (Feb. 24), Harrisburg (April 4), McLean (Feb. 24), Marshall (March 8), Metropolis (April 4), Muncie (Jan. 25-galls), Odell (Feb. 24), Paris (March 8), Pontiac (Feb. 24), Silvis (April 11), West Union (March 8), Williamsville (Feb. 24), Wilmington (Feb. 24), 1931. Davis (1910) records this species from Chicago and Kankakee. A common species in certain parts of northern Illinois, but uncommon throughout most of central and southern Illinois.

GENUS NEOPROCIPHILUS PATCH

Key to the Species of the Genus Neoprociphilus

1. Secondary sensoria present on third, fourth, and fifth antennal segments..... *attenuatus* (Osborn & Sirrine) p. 362
- Secondary sensoria restricted to third antennal segment.....
..... *aceris* (Monell) p. 361

NEOPROCIPHILUS ACERIS (MONELL)

Pemphigus aceris Monell, Canadian Entomologist, Vol. XIV, No. 1, January, 1882, p. 16.

Peoria, Illinois, is the locality from which came the cotypic specimens described by Monell (1882). The species has not again been recorded from the state until now. The information in literature concerning this aphid is meagre. On the basis of our observations concerning the biology of *N. attenuatus*, the distribution of *N. attenuatus* and *N. aceris* in Illinois, and their agreement in certain characters which are not found in other forms, we are inclined to believe that the two represent the same species—a case paralleling that of *Prociphilus tessellata* Fitch. (See following account of *N. attenuatus*.)

Mr. A. C. Maxson has checked the determination of some of our slides of this species.

Data associated with our viviparous specimens are as follows: Herod (May 29), Paris (Aug. 2), Starved Rock State Park (June 12), Urbana (Aug. 8), 1928; Homer (June 29), Rock Island (July 9), 1929. All specimens collected on plants taken on hard maple (*Acer saccharum*), except a single alate viviparous female on *Smilax rotundifolia* at Starved Rock State Park (June 12). Alates flying at Urbana (Aug. 8) and at Starved Rock State Park (June 12).



Fig. 47. Apterous viviparous females of *Neoprociphilus attenuatus* (Osborn and Serrine) clustered on lower side of stems of the smilax, *Smilax rotundifolia*; Urbana, November 4, 1929.

NEOPROCIPHILUS ATTENUATUS
(OSBORN & SERRINE)

FIG. 47

Pemphigus attenuatus Osborn and Serrine, Proceedings of the Iowa Academy of Sciences for 1892, Vol. I, part 3, (printed 1893), p. 100.

This species (Fig. 47) is here recorded for the first time from Illinois. We have discovered that at Urbana the nymphs can successfully pass the winter under leaves at the base of the *Smilax* vines on which they were produced. The life history of this species, as observed at Urbana (Frison and Ross), is as follows: continuation of species on infested *Smilax* for several successive years; development of apterous viviparous females in spring and early summer from hibernating nymphs; production of alate viviparous females in latter part of August, which migrate; production of nymphs which hibernate by the apterous females produced in late summer and fall. Just what becomes of the alate viviparous females which leave the *Smilax* in late summer has not been definitely ascertained, but they certainly either migrate to other *Smilax* vines, or an alternate host, to produce the sexual forms.

In some ways—the hibernating of the nymphs—the life history is suggestive of *Prociphilus tessellata* (Fitch). Patch (1912a) has figured the beakless oviparous female and best described the alate and apterous viviparous females. Miss Patch informs us, in answer to our query concerning this point, that these oviparous females may have been produced by the alate viviparous females after being caught and she has no definite evidence they were collected on *Smilax*. Since we have been unable to find the sexual forms on *Smilax*, we believe they are pro-

duced elsewhere and that *N. aceris* (Monell) may be another form of this species and the maple the primary host (see account of *N. aceris*).

The genus *Neoprociphilus* has been characterized as being without cornicles, but cornicles are very much in evidence in the over-wintering nymphs.

Data associated with our specimens, collected on *Smilax rotundifolia*, are as follows: Rock Island (June 24), 1928; Decatur (Oct. 5), Starved Rock State Park (Aug. 14), Urbana (Oct. 18, Nov. 7), 1929; Urbana (Feb. 15, Mar. 16, Apr. 4, May 3, 12, June 18, Aug. 25 and Sept. 18), 1930.

GENUS PEMPHIGUS HARTIG

Key to the Species of the Genus Pemphigus

1. Greatest diameter of fourth antennal segment not distinctly less than that of fifth antennal segment.....2
- Greatest diameter of fourth antennal segment distinctly less than that of fifth antennal segment; a large, membranous, irregularly shaped sensorium on distal half of both fifth and sixth antennal segments, these sensoria normally with small, more heavily chitinized, island-like areas bearing one or more setae (Fig. 240); from gall on petiole of poplar leaf, mature aphids escaping through a transverse slit (Fig. 49).....
.....[fundatrigeniae] *populi-transversus* Riley p. 367
2. Sixth antennal segment never with annular secondary sensoria.....3
- Sixth antennal segment always with annular secondary sensoria.....6
3. Sensorium on distal end of fifth antennal segment large and normally with a small, more heavily chitinized, island-like area in membranous area (Fig. 241); on roots of *Cruciferae*.....
.....[sexuparae] *populi-transversus* Riley p. 367
and
rubi Thomas p. 368
- Sensorium on distal end of fifth antennal segment small and without an island-like area in membranous area.....4
4. Fifth antennal segment without secondary sensoria.....5
- Fifth antennal segment with secondary sensoria (Fig. 229); on roots of birch.....[sexuparae] *ephemeratus* n. sp. p. 365
5. Fifth antennal segment about twice as long as greatest width and about as long as second antennal segment (Fig. 228); on roots of *Solidago*, *Erigeron*, etc...[sexuparae] *brevicornis* Hart p. 363
- Fifth antennal segment elongate, about three times as long as greatest width and conspicuously longer than second antennal segment (Fig. 227); on roots of *Bidens*.....
.....[sexuparae] *tartareus* n. sp. p. 369
6. Fourth antennal segment with from one to three, rarely four, secondary sensoria; from cockscomb-like gall on upper surface of poplar leaf.....[fundatrigeniae] *populi-venae* Fitch p. 368
- Fourth antennal segment usually with four or more secondary sensoria; from gall on petiole of poplar leaf, mature aphids escaping through a semi-circular curved slit.....
.....[fundatrigeniae] *populicaulis* Fitch p. 366

PEMPHIGUS BREVICORNIS (HART)

FIG. 228

Tychea brevicornis Hart, Eighteenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois. March 4, 1895, p. 97.

Ever since the original description in 1895 of *Tychea brevicornis* Hart, the relationships of this form have been in doubt. Collections

of root-frequenting aphids made during the fall of 1930 have proved, however, that this plant louse is a very common species on roots of *Erigeron*, *Solidago*, etc., in Illinois and that it belongs to the genus *Pemphigus* as Cutright (1925) has placed it. Our information to date indicates, too, that many or most of the sexuparae reach maturity before the ground is completely frozen and that they leave the soil for an alternate host. Those sexuparae that fail to leave the soil before it is frozen remain there during the winter and then in early spring probably fly to the alternate host.

Although predictions are hazardous, we believe that the forms now called *brevicornis* Hart will eventually be found to be the sexuparae of *populicaulis* Fitch, the latter name having priority. Only one other species of *Pemphigus* (*populi-transversus* Riley) approaches the abundance of *populicaulis* Fitch in Illinois, and the sexuparae of it have been made known by the excellent studies of Jones and Gillette (1918). The distribution and abundance of *brevicornis* Hart indicate that, if it has an alternate host, the gall which it forms on this host must be a common one; thus indicating by circumstantial evidence the gall of *populicaulis* Fitch. As already mentioned, the presence of numerous winged sexuparae in fall, the abdomens of which contain sexual forms, is indicative of an alternate host. Again, we have found in November in localities where *brevicornis* was abundant on roots, the sexuparae of a *Pemphigus*, inseparable from *brevicornis* Hart, in cracks in the bark and in scars on the trunk and branches of *Populus deltoides*. Associated with these sexuparae we have found the sexual forms and eggs, and later (June) the galls of *populicaulis*.

Little mention has been made in literature of *brevicornis* Hart since the original description. Its assignment to *Tychoides cragrostidis* Pass. by Theobald (1929) is obviously incorrect because *brevicornis* is a true *Pemphigus*. Although Cutright (1925) has sunk *brevicornis* as a synonym of *lactucae* Fitch, for the present we have not accepted this synonymy because of the possibility of the latter being some other species. If Cutright's synonymy is correct, and if our supposition about *populicaulis* is correct, the name of *lactucae* Fitch (1859) will have priority over both other names. In any case, it seems that the name *brevicornis* is doomed to synonymy as are most names applied to sexuparae.

Since there is no detailed description of the alate sexupara in literature, the following is given:

ALATE SEXUPARAE

Size and general color.—Length from head to tip of anal plate, 1.70. Color of body, antennae, and legs dark brown, except abdomen, which is green. Wings almost hyaline, very slightly infuscate with gray; veins and stigma grayish brown.

Head and appendages.—Average width of head across eyes, .36. Comparative lengths as follows: III— .16 to .23, average .18; IV— .07 to .11, average .09; V— .06 to .11, average .08; VI— .11 to .14, average .12 plus .03. Sensoria (Fig. 228) present on third and fourth segments, numbering 5 to 6, average 7, on third, and 1 to 4, average 2, on fourth. Third segment with a spine-like process near base. Fourth and fifth segments imbricated, each with an oval primary sensorium without chitinous islands.

Thorax and abdomen.—The pair of wax-pore plates on mesonotum oblique and oval, separated by slightly more than their greatest diameter (length), sometimes more nearly round and farther apart. Wax-pore plates on abdomen similar to those described for *P. tartareus*.

Data associated with our recent collections on roots of *Erigeron* and *Solidago* are as follows. Normal (July 28), 1884; Champaign (October 25), 1886; Beardstown (November 7), Effingham (November 13), Flora (November 13), Golconda (November 27), Herod (November 27), Oakwood (October 22), Watson (November 13), Willow Springs (November 4), 1930. Forms inseparable from the true *brevicornis* Hart have been collected in Illinois from crevices on trunks and branches of *Populus deltoides* as follows: Golconda (November 27) and Watson (November 13), 1930. Males, oviparous females, and eggs were found associated with dead alate sexuparae from Watson on November 13.

The cotypic slides (3171, 7659, 7666) are from Normal, Illinois, July 28, 1884, on corn roots, and Champaign, Illinois, October 25, 1886, in ant nest.

PEMPHIGUS EPHEMERATUS new species

ALATE VIVIPAROUS FEMALE (SEXUPARA)

Size and general color.—Average length from vertex to tip of cauda, 2.25. In life entire body with a downy wax coating. Specimens preserved on slide with head and thorax dark brown, abdomen yellowish-brown with seven small brownish lateral patches serially arranged. Antennae and beak concolorous with head or slightly lighter. Legs concolorous with antennae, slightly lighter than thorax, almost uniformly brown, tibiae sometimes slightly darker than femora. Stigma with posterior portion darkest, posterior dark portion extending to base of wings; veins very light bordered with light fuscous bands; posterior margin of wing brownish near junction with anal vein.

Head and appendages.—Average width of head across eyes, .49. Antennal segments with the following comparative lengths: III— .17 to .21, average .19; IV— .11 to .13, average .12; V— .14 to .17, average .15; VI— .14 to .19, average .17 plus .03 to .06, average .05. Coefficient of antennal segment VI— $1.19 \pm$; antennal coefficient $0.72 \pm$ (Maxson's formulae). Secondary sensoria (Fig. 229) present on third, fourth, and fifth antennal segments, numbering as follows: III— 5 to 9, average 7; IV— 2 to 5, average 3; V— 2 to 5, average 3. Secondary sensoria of the transverse type varying greatly in length and width, but never longer than the diameter of the segment and always in a straight row. Primary sensorium on the sixth antennal segment without marginal sensoria. Third antennal segment with spine-like process on its inner side near base of segment (Fig. 229). The beak just fails to reach the mesothoracic coxae.

Thorax and appendages.—Prothorax with two transverse, narrow wax-pore plates on the dorsum, one on each side of the meson. Mesothorax with two oblique, elliptical wax-pore plates on dorsum, separated by a distance about equal to their length and with two large oval wax-pore plates on the venter, situated immediately cephalad of the mesocoxae on the anterior-mesal angle of the pleuron. Hind tarsi about twice as long as the fourth antennal segment. Veins of fore wing ending a considerable distance before margin of wing; some fore wings with a sub-costal border.

Abdomen.—Cornicles apparently absent. Dorsal wax-pore plates apparently lacking or, if present, very indistinct; six large wax-pore plates situated on lateral margins of abdomen; a larger median wax-pore plate present just anterior to the cauda. Cauda normal in shape.

APTEROUS VIVIPAROUS FEMALE (VIRGOGENIA)

Size and general color.—Average length from vertex to tip of anal plate, 2.4. General color of body light yellowish-brown, except as follows: antennae and anterior portion of head greyish-brown; mouthparts, legs, and pleural plates brown; tibiae slightly darker than the femora, as in the alate viviparous female.

Head and appendages.—Average length of head across eyes, .43. Antennal segments with comparative lengths as follows: III— .10 to .13, average .11; IV— .04 to .06, average .05; V— .09 to .10, VI— .13 to .17, average .15 plus .03 to .04, average .04. Third and fourth antennal segments cylindrical, of almost uniform width, faintly imbricated, and without sensoria; the division between them often indistinct, represented only by a narrow contraction of the integument. Fifth segment faintly imbricate, distinctly cuneate, its diameter near apex twice that at base; apex with a circular primary sensorium fringed with hairs, subequal to sensorium on sixth segment. Sixth segment slightly imbricate, including the terminal filament longer than segments three and four together; the terminal filament distinctly defined, bearing at its apex a group of four or five short, stout spines; the single primary sensorium small, circular and fringed with hairs, its diameter subequal to that of the terminal filament. Eye small, composed of three bulging facets. Beak reaching just beyond middle coxae.

Thorax and abdomen.—Lengths of front legs average as follows: femur .51, tibia .45, tarsus .18, claw .06; middle leg with femur .49, tibia .44, tarsus .18, and claw .06; hind leg with femur .68, tibia .70, tarsus .22, and claw .06. Femora smooth and bare, tibiae with scattered short spines. Cauda and anal plate broad and gently rounded.

Holotype.—Alate viviparous female (sexupara); Herod, Illinois, October 12, 1928, on roots, probably *Betula nigra*, (Frison and Hottes). On slide with a pupa. Slide No. 10773. *Morphotype.*—Apterous viviparous female; same data as holotype. On slide with alate viviparous females, pupae, and nymphs. Slide No. 10774. *Paratypes.*—Twelve slides of alate (sexuparae) and apterous viviparous females, pupae, and nymphs with the same data as holotype, two slides of apterous viviparous females with same data except date of November 27, 1930 (Frison and Ross). Slides Nos. 10775-10785 and others unnumbered.

This species was collected on fine moss-like rootlets of *Betula nigra* where these had been exposed by erosion along the bank of a small stream. The situation at the time was quite damp and dark, due to the previous high water and the slightly overhanging bank. It may be the fall migrant of an already described *Pemphigus*, but the situation and apparently unusual host add greatly to the possibility of its being entirely new. It is described with the hope that after its recognition others will interest themselves in investigating its life cycle. It differs from all other related species known to us by the combination of characters given in the key to the species of *Pemphigus*.

PEMPHIGUS POPULICAILIS FITCH

Pemphigus populicaulis Fitch, Transactions of the New York State Agricultural Society, Vol. XVIII, 1858 (printed 1859), p. 845.

This plant louse has been previously recorded from Illinois by Walsh (1862), LeBaron (1873), Thomas (1879), and Davis (1910d). It causes a gall at the base of the leaves of poplar somewhat similar to *P. populi-transversus* except that opening is a semi-circular curved slit. Under a discussion of *P. brevicornis* Hart we have already advanced our supposition that *populicaulis* is the aerial and gall-making form of the root-feeding plant louse described as *brevicornis* Hart, and the nomenclatorial changes that must result if this theory is substantiated.

Data associated with our specimens collected in galls on species of *Populus* are as follows: Champaign (July 16), 1885; Albion (May 26), Cave-in-Rock (May 30), Oakwood (July 18), Shawneetown (May 27), Ur-

bana (July 10), 1928; Eldorado (June 19), Elizabethtown (June 20), Kansas (June 17), Oakwood (June 1), Rock Island (July 7), Starved Rock State Park (July 5), 1929; Seymour (June 20), 1930.

PEMPHIGUS POPULI-TRANSVERSUS RILEY

FIGS. 48, 98, 240, 241, 330

Pemphigus populi-transversus Riley, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, January 22, 1879, Article I, Part I, p. 15.

The details of the life history of this species are very well known because of the studies of Jones and Gillette (1918), who have shown that it alternates between poplars and the roots of various cruciferous plants. The winged migrants (fundatrigeniae) leave the galls (Fig.



Fig. 48. Leaf petiole gall on the poplar, *Populus deltoides*, caused by the migratory plant louse, *Pemphigus populi-transversus* Riley; Oakwood, July 22, 1929. The winged adults leave the gall through the transverse slit.

48) on poplars in spring or summer and fly to cruciferous plants, where the sexuparae are eventually produced. The latter return to the trunks and branches of poplars in spring and produce the sexual forms which produce eggs from which the stem mothers hatch. The stem mothers start the galls, each of which produces a large number of winged females or migrants.

We have been unable to separate the cotypic specimens of *P. rubi* Thomas (1879), which are sexuparae, from sexuparae of *P. populi-transversus* Riley. The similarity in their antennae, which are quite

different from the antennae of other sexuparae taken in Illinois, seems to us quite indicative that they are the same species.

Data associated with our Illinois material on *Populus* are as follows: Danville (Sept. 18), Elizabethtown (October 12), Golconda (October 13), Havana (June 21), Mahomet (October 2), Mt. Carmel (May 26), Pekin (July 22), 1928; Farmer City (September 22), Herod (Sept. 27), Oakwood (October 13), Starved Rock State Park (July 5), 1929; Fairmount (September 28), Watson (Nov. 13), 1930.

In addition, the sexuparae have been taken on roots of *Lepidium virginicum* at Mt. Carmel on May 26, 1928. Previously recorded from Illinois by Davis (1910) and Gronemann (1930).

PEMPHIGUS POPULI-VENAE FITCH

FIG. 94

Pemphigus populi-venae Fitch, Transactions of the New York State Agricultural Society, Vol. XVIII, 1858 (printed 1859), p. 851.

Thomas (1879), in the "Eighth Report of the State Entomologist of Illinois," lists a species of *Pemphigus* under this name but without definitely recording it from Illinois. This species has been rarely recorded in literature, and the only detailed description of its forms is that by Maxson and Knowlton (1929).

Our record establishing the occurrence of this species in Illinois is based upon the finding of the characteristic cockscomb-like galls upon the upper surfaces of leaves of *Populus deltoides* at Watson, Illinois, on November 13, 1930 (Frison and Ross).

PEMPHIGUS RUBI THOMAS

Pemphigus rubi Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 147.

As mentioned in our remarks concerning *P. populi-transversus* Riley, we are unable to separate the cotypic specimens of *rubi* Thomas, which are sexuparae, from the sexuparae of the former and believe that they are the same. Only the slight possibility of their being two different species of *Pemphigus* with similar sexuparae has prevented us from sinking one of the names in synonymy at this time. If later investigations prove these to be the same, the name of *populi-transversus* Riley will have priority.

The statement of Jackson (1907), that this species "causes a curling and twisting of the leaves" of raspberry, is evidently without foundation. Jackson himself states he is not familiar with this species, and a check of all references known to us does not reveal such a statement by others. Even Thomas, when he described *rubi*, stated that "it is possible that these specimens were accidentally on the raspberry."

The cotypic slides, numbers 2767 and 2768, are alate viviparous females (sexuparae) collected at Carbondale, Illinois, April 12, 1878, on raspberry, by G. H. French.

PEMPHIGUS TARTAREUS new species

FIG. 227.

ALATE VIVIPAROUS FEMALE (FALL MIGRANT OR SEXUPARA)

Size and general color.—Average length from vertex to tip of cauda, 2.38. Head, antennae, beak, thorax, and legs, dark brown, with sutures paler. Abdomen pulverulent, pale whitish green, with spiracles, anal plate, and wax-pore plates greenish or brownish. Wings slightly infusate with brownish; front wings with costa, subcosta, stigma and posterior margin of wing in vicinity of anal vein deeply infusate with brownish, remaining veins paler; hind wings with veins still paler.

Head and appendages.—Average width of head across eyes, .41. Antennal segments with comparative lengths as follows: III— .21 to .24, average .22; IV— .11 to .13, average .13; V— .10 to .14, average .12; VI— .14 to .19, average .16 plus .04. Coefficients determined according to Maxson's formulae are as follows: antennal coefficient, 0.825; and coefficient of sixth antennal segment, 0.909. Secondary sensoria (Fig. 227) restricted to third and fourth antennal segments, linear-oval, with their margins wrinkled, arranged in a straight row on the dorsal side of the segment and numbering from 5 to 7, average 6, on the third segment, and 2 to 3, average 2.5, on the fourth. The third segment may have two or three small, round to oval, lateral sensoria. Primary sensorium on sixth antennal segment apparently without marginal sensoria. Third antennal segment with a very small, spine-like process on its inner side near base of segment. Flagellum of antenna imbricated. Beak reaching midway between pro- and mesothoracic coxae.

Thorax and appendages.—Prothorax with a lanceolate wax gland on each side of the dorso-meson. Mesothorax with an oval wax gland on each side of dorso-mesal line, separated by twice their greatest diameter, and in line with the base of the mesothoracic wings. Metathorax also with a pair of oval wax glands, in line with the other paired dorsal glands. Stigma of fore wings ending very abruptly, veins failing to reach margin of wing.

Abdomen.—Abdomen with seven pairs of lateral wax glands, those towards the posterior portion of abdomen very large. Dorsum typically with six pairs of wax glands, the basal ones largest, the posterior ones usually gradually decreasing in size, sometimes a pair coalescing, but varying greatly in shape and degree of coalescence. Seventh abdominal segment with an extremely large, oval, wax gland on the mid-dorsal region. The single condition is presumably due to the confluence of two paired wax glands. Cornicles apparently absent. Cauda normal and with but few hairs.

Holotype.—Alate viviparous female (sexupara); Decatur, Illinois, October 21, 1929, on roots of *Bidens* sp., (F. C. Hottes). Slide No. 10708.

Paratypes.—Fifteen slides in all, containing alate viviparous females and pupae; ten slides same data as holotype; one slide, Oak Park, Illinois, October 9, 1909, on roots of *Bidens*, (J. J. Davis); four slides, Lafayette, Indiana, October 3, 1913, on roots of *Bidens*, (J. J. Davis). Slides Nos. 10709-10717 and others unnumbered.

When the complete life cycles and seasonal forms of previously described species of *Pemphigus* become known, this species will likely be found to be the sexupara of one of them. At present, however, fall migrants of only two species of *Pemphigus* are authentically correlated with the spring, or gall making, forms. It is, therefore, impossible to place this form satisfactorily in our present system of classification, and it is best recorded as a new species. Mr. A. C. Maxson, to whom specimens were submitted for an opinion concerning their identity, concurs with this view. The specimens in the paratype series collected by Davis at Oak Park were recorded by him (1911b) as *P. betae* Doane.

The characters given in the key to the species of the genus *Pemphigus* are sufficient to differentiate this species from related and described forms.

GENUS PROCIPHILUS KOCH

Key to the Species of the Genus *Prociphilus*

1. Wax-pore plates on mesonotum separated by a distance equal to several times their greatest diameter (Fig. 330); fore tibiae and antennae about equal in length; large species, body about 4 mm. in length; in congested colonies on branches of beech.. *imbricator* (Fitch) p. 372
- Wax-pore plates on mesonotum separated by a distance less, or but slightly more, than their greatest diameter (Fig. 329); fore tibiae much shorter than length of antennae; smaller species, body rarely exceeding 2 mm. in length; not found on beech 2
2. Sixth antennal segment with no secondary sensoria.....[fundatrigeniae] *corrugatus* (Sirrine) p. 370
- Sixth antennal segment with one or more secondary sensoria..... 3
3. Third antennal segment usually with twelve or more secondary sensoria 4
- Third antennal segment normally with less than twelve secondary sensoria 6
4. Wax-pore plates on dorsum of mesothorax triangular in outline (Fig. 328)[fundatrigeniae and sexuparae] *venafuscus* (Patch) p. 373
- Wax-pore plates on dorsum of mesothorax oval in outline (Fig. 329) 5
5. Veins of fore wing conspicuously margined with fuscous border; on roots of many plants..[sexuparae] *erigeronensis* (Thomas) p. 371
- Veins of fore wing not margined with fuscous border; on pomaceous trees.....[sexuparae] *corrugatus* (Sirrine) p. 370
6. Fourth and fifth antennal segments approximately the same length; fourth antennal segment about equal in length to front tarsi; wax-pore plates on mesonotum separated by a distance about equal to, or less than, their shortest diameter.. *fraxinifolii* (Riley) p. 371
- Fourth antennal segment conspicuously shorter than the fifth; fourth antennal segment about equal in length to one-half length of front tarsi; wax-pore plates on mesonotum separated by a distance about equal to, or more than, their greatest diameter *tessellata* (Fitch) p. 373

PROCIPHILUS CORRUGATUS (SIRRINE)

FIG. 329

Pemphigus corrugatus Sirrine, Proceedings of the Iowa Academy of Sciences for 1893, Vol. I, Part 4, 1894, p. 130.

Davis (1910d) has recorded as questionably this species some specimens that he collected on *Crataegus*, July 7, 1907, at LeRoy, Illinois. At a later date of the same year he changed this determination to *Pemphigus*, saying it "may be Fitch's *P. pyri*." A slide of this LeRoy material was very kindly sent to us for study by Mr. Davis. We find, as Davis finally concluded, that the specimens undoubtedly belong to

the genus *Pemphigus* and, judging by Baker's (1916a) figures, are not *pyri* Fitch, which is a *Prociphilus*. The life history of the species is but poorly understood.

The data associated with our two Illinois collections of this species are as follows: Antioch (June 15), 1928; Starved Rock State Park (May 13), 1930; collected on *Crataegus* and *Amelanchier*, respectively. The material from Antioch apparently represents stem mothers and nymphs, and that from Starved Rock State Park the alate (fundatrigeniae) and apterous viviparous females.

PROCIPHILUS ERIGERONENSIS (THOMAS)

Tychea erigeronensis Thomas, Eighth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois, 1879, p. 168.

A study of the original description and probable cotypic specimens of *Tychea erigeronensis* Thomas, the studies of Forbes and Hart (1895), and recent collections of our own, all clearly indicate that one of our common subterranean aphids in Illinois is the *Tychea erigeronensis* of Thomas. Furthermore, the studies of Patch (1918) and Cutright (1925), and their drawings of the rare alate form, indicate that this species is generically best placed as a *Prociphilus*; and this placement is supported also by an opinion expressed to us in a letter from Mr. A. C. Maxson. It seems to us that *Tychea radicola* Oestlund (1886) and *Tychea erigeronensis* Thomas (1879) are the same species, as Forbes and Hart (1895) have previously stated. Maxson in a letter to us writes that "*radicola* Oestlund may be identical with the *Tychea erigeronensis* Thomas." The best account of the life-history of this species is that given by Cutright (1925). Whether it migrates and produces aerial forms is still unknown.

Our Illinois host records for this root-feeding species are: *Taraxacum officinale*, *Erigeron philadelphicus*, and species of grass. Locality and seasonal records are as follows: Normal (April 24), 1884; Urbana (March 19, Nov 25), 1890; Urbana (April 23, 26), 1892; Urbana (April 9-19), 1894; Urbana (Sept. 22, Oct. 25), 1928; Champaign (April 27), Urbana (April 2, May 1, July 22), 1929; Oakwood (Oct. 22), and Urbana (Sept. 22, Nov. 18), 1930. The data associated with probable cotypes (Slide No. 2769) are "roots of endive and *Erigeron canadense*, collector T. J. Burrill."

PROCIPHILUS FRAXINIFOLII (RILEY)

FIG. 49

Pemphigus fraxinifolii Riley, Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V, No. 1, 1879, Art. 1, p. 17.

This greenish and pulverulent aphid was described by both Riley (1879) and Thomas (1879) under the same name. The description of Riley, however, has priority over that of Thomas. It is a very common species in all parts of Illinois on ash (*Fraxinus*) and has been previously recorded from our state by Davis (1910d). It may well be classed as an important pest of this tree because of the direct injury that it causes and the unsightly appearance of trees infested with the pseudo-leaf galls (Fig. 49). According to Davis (1910d), the sexual

forms are produced in fall and the eggs laid in crevices of the bark of ash trees. Definite information as to an alternate host of this plant louse is lacking, and it may be that the entire life cycle is spent upon the ash.

All the typic material of *Pemphigus fraxinifolii* Thomas, previously recorded by Davis (1913), is now mounted on two slides. Slide No. 2762 is designated as the *lectotypic* slide and Slide No. 7167 as a *paratypic* slide. Data associated with these slides are: Sauk City, Wisconsin, June, on *Fraxinus quadrangulata*, collected by Bundy.



Fig. 49. Pseudo-gall on leaves of the white ash, *Fraxinus americana*, caused by *Prociphilus fraxinifolii* (Riley); Urbana, June 16, 1929. Normal foliage on right and infested twig on left.

Data associated with our specimens, all collected on ash (*Fraxinus* sp.), are as follows: Freeport (June 20), 1920; Antioch (June 15), Bement (July 17), Champaign (July 8), Havana (June 22), Kankakee (June 29), Metropolis (June 1), Rock Island (June 23), St. Joseph (Aug. 5), Urbana (July 5), 1928; Anna (June 21), Cairo (June 22), Effingham (June 18), Elizabethtown (June 20), El Paso (July 5), Grayville (June 19), Harrisburg (May 28), Jerseyville (June 25), Lisle (July 14), Maryville (Sept. 11), Newton (June 17), Oregon (July 10, 11), Rock Island (July 7), 1929; Starved Rock State Park (May 13), 1930.

PROCIPHILUS IMBRICATOR (FITCH)

FIG. 97

Eriosoma imbricator Fitch, Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 68.

Apparently this species has not been recorded heretofore from Illinois. Like many other species, it is mentioned in the Eighth Re-

port of the State Entomologist of Illinois by Thomas (1879) but not recorded or stated to be found in the state. The species is a large and exceedingly flocculent one, feeding and living in congested colonies on the larger branches of its host, the beech. Often it produces so much honey-dew that the ground beneath the infestation becomes discolored. Almost nothing has been published concerning the life history of this plant louse, a species which is somewhat of a misfit in either the genus *Prociphilus* or *Pemphigus*.

Our specimens were taken on beech (*Fagus grandifolia*) at Jonesboro, Sept. 28, 1929.

PROCIPHILUS TESSELLATA (FITCH)

Eriosoma tessellata Fitch, Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, State of New York, January 14, 1851, p. 68.

This species was first recorded from Illinois by Davis (1910d), who collected specimens on alders growing in the Chicago parks. According to Davis and several other authors, this plant louse is capable of causing injury to alders used in ornamental plantings. Biologically this species is of special interest, in addition to its migratory habits, because it is one of the few aphids known to hibernate in numbers in the nymphal stage. The sexual forms are produced on maples by migrants leaving the alders in fall. The over-wintering eggs produce stem mothers in spring which produce generations (*acerifolii* Riley) destined to return in summer to alders. Although the life cycle is interrupted on its probable original host, the maple, the life cycle may continue without interruption on alders. The first person to work out the life history of this species was Patch (1908, 1911b), whose findings were confirmed by the extensive studies of Pergande (1912).

Data associated with our specimens, all collected on alder (*Alnus* sp.), are as follows: Herod (Nov. 29, 30), 1928; Herod (June 21), 1929.

PROCIPHILUS VENAFUSCUS (PATCH)

FIG. 328

Pemphigus venafuscus Patch, Entomological News, Vol. XX, No. 7, July, 1909, p. 319.

Only one specimen of this species, a fall migrant, has been taken in Illinois. Patch (1909b) has shown that in Maine the fall migrants may be taken on lilac, elm, and ash, on all of which the sexual forms were produced and winter eggs subsequently laid. The spring forms were found to develop "in the angles of the twigs or about the swelling buds" of lilacs and ash. Besides her first illustrations of this species, additional figures of the curious wax-pore plates (Fig. 328) of the thorax, and of the antennae, are given in a later publication (1918).

Our specimen, a sexupara, was collected at Watson, Illinois. November 13, 1930, on the bark of *Populus deltoides*. It may have been a "stray" on *Populus*.

GENUS THECABIUS KOCH

THECABIUS SPECIES

Since we have been unable to secure alate specimens, the specific identification of our *Thecabius* material has been impossible. A British species of *Thecabius*, as well as *T. populi-conduplicifolius* (Cowen) in the United States, is known to migrate between *Populus* and *Ranunculus*, the former being the over-wintering host.

Our apterous material has been examined by Mr. A. C. Maxson, who reports that specimens taken on the stems and crowns of *Ranunculus* plants at Starved Rock State Park (August 14-September 10, 1929) are probably *T. gravicornus* Patch. What is apparently another species of this genus was collected in leaves of *Lysimachia* at the following places and dates: Kankakee (June 29, July 15), 1928; Beach (Aug. 28, 29), 1929. The apterous forms of all our material produced considerable flocculent secretions.

GENUS TRIFIDAPHIS DEL GUERCIO

TRIFIDAPHIS PHASEOLI (PASSERINI)

Tychea phaseoli Passerini, Gli Afidi, 1860, p. 39.

This subterranean species has not been previously reported from Illinois. According to Garman (1895) and Theobald (1929), it is capable of causing severe injury to garden beans. The best account in English of *T. phaseoli* is that given by Theobald (1929). Mordvilko (1928a) has indicated that *T. radicola* (Essig) is a synonym of *phaseoli* and in certain parts of Europe other forms not thus far found in America produce galls on *Pistacia*. According to our present information, this species is anolocyclic in America.

Mr. A. C. Maxson has kindly determined our apterous specimens of this species. They were collected on the roots of sweet peas (*Lathyrus* sp.) in a greenhouse at Maywood, Illinois, on April 12, 1923, by Mr. C. C. Compton.

SUBFAMILY MINDARINAE

SUPERTRIBE MINDAREA

GENUS MINDARUS KOCH

MINDARUS ABIETINUS KOCH

Mindarus abietinus Koch, Die Pflanzenläuse Aphiden getreu nach dem Leben abgebildet und beschrieben, Nürnberg, 1857, p. 278.

This species was described by Thomas (1879) in the "Eighth Report of the State Entomologist of Illinois," as a new species under the name of *Schizoneura pinicola*. Patch (1910b) and Davis (1913) have shown that the species described by Thomas is synonymous with *M. abietinus* Koch. It is rather strange that the species has not been

recorded from Illinois since its collection by Thomas. According to Patch (1910b), who gives a good description of the alate and apterous viviparous females, it develops in "curly tips of *Abies balsamea* Mill. and *Picea canadensis* Mill."

Data associated with the typic slide of *S. pinicola* Thomas in the Survey collection (Slide No. 2774) are as follows: Carbondale, Illinois, April 20, 1879, on young white pine, by C. Thomas.

SUBFAMILY HORMAPHIDINAE

SUPERTRIBE HORMAPHEA

Key to Genera

1. Antennae of alate forms with five segments.....**Hamamelistes** p. 375
- Antennae of alate forms with three segments.....**Hormaphis** p. 376

GENUS HAMAMELISTES SHIMER

HAMAMELISTES SPINOSUS SHIMER

FIG. 50

Hamamelistes spinosus Shimer, Transactions of the American Entomological Society, Vol. I, 1867, p. 284.

Like *Hormaphis hamamelidis* (Fitch), this plant louse has a complicated and most interesting life history. It alternates, too, between the same two hosts—witch-hazel and birch. Its life history (Pergande, 1901) differs from that of *H. hamamelidis*, as outlined under that species, principally as follows: the over-wintering eggs are laid on witch-hazel in spring or early summer and do not hatch until the following spring; the galls on witch-hazel (Fig. 50) caused by the stem mothers are bud-galls of spiny appearance; in addition to the over-wintering eggs on witch-hazel there is a *coccidiform* (Fig. 332) generation which over-winters on the birch and their offspring produce the common corrugations, or pseudo-galls, on the leaves; and the winged migrants produced on the birch return to the witch-hazel in late spring and produce the sexual generation.

Neotypic slide.—Since this species was originally described by Shimer from specimens collected in Illinois (Mt. Carroll), and we have no knowledge that the types were ever preserved, a slide from the Survey collection is selected as the *neotype*. The data associated with the neotypic slide are as follows: Slide No. 8144, collected on witch-hazel, Starved Rock State Park, Illinois, August 14, 1929, by T. H. Frison and F. C. Hottes.

This species is very generally distributed over Illinois. We have taken the galls and second-generation material on witch-hazel (*Hamamelis virginiana*) at Urbana (July 26 and December 2, 1928, and July 23, 1929) and at Starved Rock State Park (August 14, 1929). The pseudo-galls on birch and associated generations have been collected as follows: Antioch (June 15), Carbondale (June 4), East Dubuque (June 25), Galena (June 25), Kankakee (June 29), Oregon (June 28), Quincy (June 6), Rock Island

(June 24), 1928; Macomb (May 4), Waukegan (July 13), 1929. Davis (1910) has recorded the species from Chicago and Kankakee on witch-hazel, and Gronemann has sent us material from Elgin (September, 1930) upon which his "near Chicago" record (1930) is based.



Fig. 50. Spiny bud gall on the witch-hazel, *Hamamelis virginiana*, caused by *Hamamelistes spinosus* Shimer; Urbana, July 24, 1929.

GENUS *HORMAPHIS* OSTEN SACKEN

HORMAPHIS *HAMAMELIDIS* (FITCH)

Bryocrypta hamamelidis Fitch, Fourth Annual Report of the Regents of the University on the Condition of the State Cabinet of Natural History, January 14, 1851, State of New York, p. 69.

Few plant lice present a more remarkable or more diversified life cycle than this and the preceding species. Like *Hamamelistes spinosus*

Shimer, it too, alternates between the witch-hazel and the birch. The complicated life history of this species was worked out by Pergande (1901) and published after "nearly twenty-two years of patient labor." The winter is passed in the egg stage on witch-hazel. The stem mothers hatching from these eggs in spring cause the formation of conical galls on the upper sides of the leaves, and in these galls they produce a second generation of aphids which are winged and migratory. These winged forms migrate to birches in late spring or early summer and produce generations which in their last stages are remarkably suggestive of the white-flies and are referred to in literature as *aleurodi-form* generations. In late summer or early fall these aleurodi-form generations, in turn, produce a generation of winged forms, or migrants, which return to the witch-hazel and produce the sexual forms that lay the over-wintering eggs.

This species has not been previously recorded from Illinois, except for the record by Gronemann (1930) from the "Chicago area." Mr. Gronemann has kindly supplied us with actual specimens of his collecting from Elgin, Illinois, on witch-hazel. During the past three years of collecting we have taken the species but once, at Starved Rock State Park, June 12-13, 1928, on witch-hazel (*Hamamelis virginiana*).

PART III

KEYS TO SPECIES OF PLANT LICE GROUPED WITH
REFERENCE TO HOST PLANTS

For the convenience and use of workers in the field of economic entomology, and others interested only in naming a few of the commoner and more important plant lice, we have prepared ten special keys, based upon natural or well-known artificial groupings of plants serving as hosts for aphids. These keys have been made as simple as possible, and in most cases the characters used can be seen with the aid of a hand lens or a wide-field binocular microscope.

We have included in these keys only the species of plant lice most likely to be found in Illinois on certain natural or artificial groupings of plants, using the data assembled by our field collecting in all parts of the state as the basis for the selection of the included species. In other geographical or political areas these keys will require the incorporation of additional species. Even in Illinois they are not complete, because to make them so would entail the addition of numerous polyphagous species of very little economic importance and the expansion of the keys to a point where they would be necessarily comparable to the more technical keys in Part II.

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON
APPLE IN ILLINOIS

1. Secondary sensoria of antennal segments in the form of narrow ring-like structures almost encircling antennae, antennae therefore with a corrugated or notched appearance when seen from the side (Fig. 225); terminal filament of sixth segment shorter than basal portion (Fig. 244); covered in life with long white woolly secretions (Fig. 42); on trunks and roots of host.....*Eriosoma lanigera* (Hausmann) p. 351
- Secondary sensoria of antennal segments circular or oval (Figs. 262, 266); terminal filament of sixth segment much longer than basal portion (Fig. 266); not covered in life with white woolly secretion although sometimes slightly pulverulent (Fig. 30); on leaves and twigs of host.....2
2. Cornicles short, but slightly if any longer than hind tarsi or basal portion of sixth antennal segment; dorsum of abdomen with a large dark-colored dorsal patch anterior to cornicles; migrating from apple to clovers and alfalfa.....*Aphis bakeri* Cowen p. 181
- Cornicles of medium length, about twice as long as hind tarsi or basal portion of sixth antennal segment; dorsum of abdomen with or without a large dark-colored dorsal patch anterior to cornicles3
3. Abdomen with a large dark-colored spot on dorsum anterior to cornicles; third antennal segment much longer than width of head through the eyes; apterous forms slightly pruinose...*Aphis rosea* Baker p. 214
- Abdomen with dorsum essentially greenish, without a dark-colored spot anterior to cornicles; third antennal segment no longer than width of head through the eyes.....4

4. Cornicle distinctly constricted before conspicuous flaring flange at apex (Fig. 134); secondary sensoria on fourth antennal segment numerous; cauda stout and not sharply constricted near middle (Fig. 196).....*Rhopalosiphum prunifoliae* (Fitch) p. 239
- Cornicle not constricted before apex and without conspicuous flaring flange (Figs. 130, 133, 139); secondary sensoria on fourth antennal segment lacking or few; cauda sharply constricted near middle (Fig. 203).....*Aphis pomi* DeGeer p. 210

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON BERRIES IN ILLINOIS

1. On blackberry2
- On raspberry3
- On gooseberry4
- On strawberry6
- On currant; pale yellowish aphid feeding on lower surface of leaves and causing them to become distorted and reddish (Fig. 34).....*Capitophorus ribis* (Linnaeus) p. 290
- On grape; brownish aphid feeding on lower surface of leaves and on tendrils (Fig. 22).....*Aphis illinoisensis* Shimer p. 198
2. Antennae five-segmented; apterous forms yellowish white; causes curling of leaves particularly near tips of canes.....*Cerosipha rubifolii* (Thomas) p. 229
- Antennae six-segmented; apterous forms greenish; beneath leaves and on stems.....*Aphis rubicola* Oestlund p. 215
3. Cornicles long and distinctly swollen (Fig. 121); species of large size; on stems of new growth.....*Amphorophora sensoriata* Mason p. 279
- Cornicles cylindrical and not swollen (Fig. 130); species of minute size; beneath leaves and on stems.....*Aphis rubicola* Oestlund p. 215
4. Third antennal segment much shorter than width of head through eyes; terminal filament short, not over three times as long as basal portion.....*Aphis sanborni* Patch p. 218
- Third antennal segment longer than width of head through eyes; terminal filament long, at least six times as long as basal portion5
5. Fifth antennal segment with few secondary sensoria (0 to 5).....*Myzus houghtonensis* (Troop) p. 338
- Fifth antennal segment with secondary sensoria more numerous (7 to 20).....*Myzus thomasi* n. sp. p. 343
6. Black or bluish-black aphid; apterous forms without capitate setae (Fig. 324); on roots, crowns or stems.....*Aphis forbesi* Weed p. 194
- Pale yellowish white or greenish aphid; apterous forms with capitate setae (Fig. 320); on undersides of leaves and stems.....7
7. Apterous forms with conspicuous capitate setae scattered over entire body; third antennal segment with secondary sensoria widely scattered and numbering about thirty.....*Capitophorus fragaefolii* (Cockerell) p. 283
- Apterous forms with conspicuous capitate setae restricted almost entirely to head and anal regions of abdomen; third antennal segment with secondary sensoria less scattered and numbering about twenty.....*Capitophorus minor* (Forbes) p. 284

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON COMMON GARDEN FLOWERS IN ILLINOIS

1. Partial to rose2
- Partial to aster9
- Partial to chrysanthemum11

— Partial to sunflower	12
— Partial to sweet pea	13
— Common to variety of flowers.....	14
— Partial to columbine; medium-sized, yellowish green form with dark dorsal markings.....	<i>Myzus essigi</i> Gillette and Palmer p. 337
— Partial to nastertium; medium-sized, bluish to blackish form, often with white spots on dorsum (Fig. 26).....	<i>Aphis rumicis</i> Linnaeus p. 215
— Partial to delphinium; medium-sized, reddish-brown to blackish species.....	<i>Aphis rociadae</i> Cockerell p. 214
— Partial to golden glow; large reddish species (Fig. 38).....	<i>Macrosiphum rudbeckiae</i> (Fitch) p. 320
2. Apterous forms with numerous capitate or clubbed setae over surface of body (Fig. 82).....	3
— Apterous forms with simple setae (Fig. 84).....	5
3. Alate forms with secondary sensoria present at least on third and fourth antennal segments.....	<i>Capitophorus fragaefolii</i> (Cockerell) p. 283
— Alate forms with secondary sensoria restricted to third antennal segment	4
4. Cornicles much longer than fourth antennal segment, basal portion light shading to dark at apices; hind tibiae uniformly dark.....	<i>Capitophorus corambus</i> n. sp. p. 281
— Cornicles shorter or about same length as the fourth antennal segment, uniformly dark; hind tibiae mostly light-colored with apices dark and contrasting.....	<i>Capitophorus tetraerhodus</i> (Walker) p. 291
5. Cornicles reticulated at apex (Fig. 108).....	6
— Cornicles not reticulated at apex (Fig. 129).....	8
6. Cornicles black, strongly contrasting with color of abdomen.....	7
— Cornicles with at least basal portion concolorous with abdomen and not contrasting with it.....	<i>Macrosiphum gei</i> (Koch) p. 306
7. Abdomen uniformly greenish or reddish; cornicles shorter than third antennal segment.....	<i>Macrosiphum pseudorosae</i> Patch p. 318
— Abdomen greenish with dark lateral patches; cornicles about as long as, or longer than, third antennal segment.....	<i>Macrosiphum rosae</i> (Linnaeus) p. 320
8. Antennal tubercles well developed (Fig. 86); secondary sensoria on third antennal segment arranged approximately in a straight row.....	<i>Myzus porosus</i> Sanderson p. 340
— Antennal tubercles poorly developed (Fig. 84); secondary sensoria on third antennal segment not arranged in a straight row	<i>Macrosiphum dirhodum</i> (Walker) p. 304
9. On roots.....	<i>Aphis maidi-radicis</i> Forbes p. 202
— On leaves or stems.....	10
10. Cornicles much shorter than third antennal segment.....	<i>Macrosiphum anomalae</i> n. sp. p. 298
— Cornicles approximately as long as third antennal segment.....	<i>Macrosiphum erigeronensis</i> (Thomas) p. 304
11. Predominantly dark reddish brown or blackish.....	<i>Macrosiphum sanborni</i> Gillette p. 323
— Predominantly greenish.....	<i>Rhopalosiphum rufomaculatum</i> (Wilson) p. 241
12. Cornicles very short, about as long as hind tarsi; a small bluish form tightly curling the leaves (Fig. 20).....	<i>Aphis debilicornis</i> Gillette and Palmer p. 191
— Cornicles at least twice as long as hind tarsi; a small yellowish-green form on lower sides of leaves.....	<i>Aphis helianthi</i> Monell p. 196
— Cornicles elongate, four or five times as long as hind tarsi; a large yellowish form with dark markings on lower sides of leaves.....	<i>Macrosiphum illini</i> n. sp. p. 309

13. On roots; winged form with media simple (Fig. 64); terminal filament of alate or apterous forms about as long as basal portion of sixth antennal segment.....*Trifidaphis phaseoli* (Passerini) p. 374
- On stems and leaves; winged form with media branched (Fig. 72); terminal filament of alate and apterous forms much longer than basal portion of sixth antennal segment.....*Macrosiphum pisi* (Kaltenbach) p. 317
14. Cornicles much shorter than width of head through eyes; medium sized bluish to blackish form, often with white dorsal spots (Fig. 26).....*Aphis rumicis* Linnaeus p. 215
- Cornicles about as long or longer than width of head through eyes; medium to large, sized yellowish or greenish forms, sometimes with dark dorsal markings.....15
15. Large greenish form, without dark markings on dorsum of abdomen; cornicles with closed reticulations at apices (Fig. 103); antennal tubercles poorly developed (Fig. 84).....*Macrosiphum gei* (Koch) p. 306
- Medium-sized greenish forms, usually with dark markings on dorsum of abdomen; cornicles without closed reticulations at apices (Fig. 124); antennal tubercles well developed (Fig. 86)16
16. Cornicles slightly swollen near apex and about as long as width of head through eyes; apterous forms with dorsum of abdomen uniformly yellowish green.....*Myzus persicae* (Sulzer) p. 339
- Cornicles cylindrical, much longer than width of head through eyes; apterous forms usually with a dark horseshoe-shaped patch on dorsum contrasting with ground color of yellowish green.....*Myzus circumflexus* (Buckton) p. 335

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON GRAIN CROPS IN ILLINOIS

1. On roots2
- On leaves or stems.....3
2. Cornicles present, about as long as hind tarsi, and cylindrical (Fig. 23); terminal filament of sixth antennal segment much longer than base of segment (Fig. 266).....*Aphis maidi-radicis* Forbes p. 202
- Cornicles absent or ring-like and inconspicuous (Fig. 158); terminal filament of sixth antennal segment much shorter than base of segment (Fig. 241); several species of slight economic importance*Eriosomatinae* sp. p. 345
3. Body with numerous long, sharp, spine-like hairs; cornicles ring-like, inconspicuous*Sipha flava* (Forbes) p. 174
- Body without strong, spine-like hairs; cornicles cylindrical, conspicuous, at least as long as hind tarsi.....4
4. Medial vein of front wing only once branched (Fig. 70).....*Toxoptera graminum* (Rondani) p. 241
- Medial vein of front wings twice branched (Fig. 72).....5
5. Terminal filament of sixth antennal segment about twice length of basal portion; hind tibiae unicolorous, brown or black.....*Aphis maidis* Fitch p. 205
- Terminal filament of sixth antennal segment over three times length of basal portion; hind tibiae light yellowish with apices black6
6. Cornicles long and slender, about as long as width of head through eyes, slightly tapering to apex; apical third with closed reticulations (Fig. 114); cornicles and cauda greatly contrasting in color.....*Macrosiphum granarium* (Kirby) p. 308
- Cornicles shorter and stouter, much shorter than width of head through eyes, constricted before apical flange; imbricate but without closed reticulations (Fig. 134); cornicles and cauda more or less concolorous, not contrasting.....*Rhopalosiphum prunifoliae* (Fitch) p. 239

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON
PLANTS IN GREENHOUSES IN ILLINOIS

1. Wings with conspicuous dusky brown shading outlining all veins (Figs. 66, 74).....2
- Wings without dark shading outlining veins (Fig. 70).....4
2. Cornicles slightly swollen.....3
- Cornicles cylindrical and tapering towards apex; on fern.....
.....*Idiopterus nephrolepidis* Davis p. 292
3. Hind wings normally with two oblique veins (Fig. 93); on violets
.....*Idiopterus violae* (Pergande) p. 292
- Hind wings normally with one oblique vein (Fig. 95); closed cell
always present in fore wings and at least four-sided (Fig. 74);
on bananas and other tropical plants.....*Pentalonia nigronervosa* Coquerel p. 345
4. Predominant color some shade of brown or black.....5
- Predominant color yellowish, pink, or some shade of green.....8
5. Cornicles short, scarcely longer than hind tarsi.....
.....*Aphis padi* Linnaeus p. 209
- Cornicles longer, at least twice as long as hind tarsi.....6
6. Cornicles with apical portion conspicuously swollen (Fig. 148);
restricted to aquatic or semi-aquatic plants.....
.....*Rhopalosiphum nymphaeae* (Linnaeus) p. 238
- Cornicles cylindrical or gradually tapering to apex, not swollen,
or at most apex is but slightly enlarged (Fig. 106); not asso-
ciated with aquatic or semi-aquatic plants.....7
7. Dark reddish brown; cornicles much wider at base than at apex,
reticulate for much of their length; restricted to chrysanthemum.....*Macrosiphum sanborni* Gillette p. 323
- Black to bluish black, often with small white spots on dorsum;
cornicles but slightly wider at base than at apex, imbricated
but not reticulated at apex; infesting a great variety of plants
.....*Aphis rumicis* Linnaeus p. 215
8. On roots.....9
- Not on roots.....10
9. Medius of fore wing branched (Fig. 72); alate or apterous forms
with terminal filament much longer than basal portion of sixth
segment (Fig. 266); cornicles present in all forms; on roots
of Aster, Erigeron, and other Compositae.....
.....*Aphis maidi-radicis* Forbes p. 202
- Medius of fore wing simple (Fig. 64); alate or apterous forms
with terminal filament shorter or at least not longer than basal
portion of sixth segment (Fig. 245); cornicles absent in all
forms; on roots of sweet pea.....*Trifidaphis phaseoli* (Passerini) p. 374
10. Cornicles short, less than width of head through the eyes; spe-
cies of small size.....11
- Cornicles long, as long or much longer than width of head
through the eyes; species of medium to large size.....13
11. Fourth antennal segment without secondary sensoria; likely to
be found on a variety of plants.....*Aphis gossypii* Glover p. 195
- Fourth antennal segment with secondary sensoria.....12
12. Cornicles much longer than basal portion of sixth antennal seg-
ment; cauda elongate and rather pointed; dorsum of abdomen
greenish; restricted to chrysanthemums.....
.....*Rhopalosiphum rufomaculatum* (Wilson) p. 241
- Cornicles about as long as basal portion of sixth antennal seg-
ment; cauda not elongate, rounded; dorsum of abdomen with
dark markings on a greenish background; on *Senecio cruentus*
.....*Aphis padi* Linnaeus p. 209

13. Cornicles exceedingly long, between one and one-half and two times as long as width of head through eyes; species of very large size14
- Cornicles of moderate length, about as long as width of head through eyes; species of medium size.....16
14. Apex of cornicles without closed reticulations (Figs. 118, 119); body, legs, and cornicles almost uniformly greenish; on sweet peas.....*Macrosiphum pisi* (Kaltenbach) p. 317
- Apex of cornicles with closed reticulations (Fig. 111); partial to roses15
15. Secondary sensoria on third antennal segment approximately in a straight row (Fig. 293); cornicles uniformly tapering to apex (Fig. 111), with basal portion greenish and apices dusky; abdomen green or pink; on a variety of plants.....*Macrosiphum gei* (Koch) p. 306
- Secondary sensoria on third antennal segment not approximately in a straight row (Fig. 288); cornicles somewhat constricted at apex before flange (Fig. 108), uniformly black; abdomen green with black lateral spots; on rose.....*Macrosiphum rosae* (Linnaeus) p. 320
16. Antennal tubercles well developed (Fig. 86); cornicles cylindrical or but slightly swollen near apex; on a variety of plants.....17
- Antennal tubercles poorly developed (Fig. 80); apical half of cornicles conspicuously swollen; on aquatic or semi-aquatic plants.....*Rhopalosiphum nymphaeae* (Linnaeus) p. 238
17. Cornicles slightly swollen near apex and about as long as width of head through eyes; apterous forms with dorsum of abdomen uniformly yellowish green.....*Myzus persicae* (Sulzer) p. 339
- Cornicles cylindrical, much longer than width of head through eyes; apterous forms usually with a dark horseshoe-shaped patch on dorsum contrasting with ground color of yellowish green.....*Myzus circumflexus* (Buckton) p. 335

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON LEGUMES IN ILLINOIS

1. Cornicles inconspicuous, short or cone-shaped (Fig. 155), not much if any longer than width at base.....2
- Cornicles conspicuous, cylindrical or elongate (Fig. 100), much longer than width at base.....3
2. Terminal filament of sixth antennal segment much longer than basal portion; veins of wings not conspicuously margined with fuscous (Fig. 70); hind tibiae about four times as long as hind tarsi; apterous forms with ordinary setae (Fig. 324)....*Sipha flava* (Forbes) p. 174
- Terminal filament of sixth antennal segment about as long as basal portion; veins of wings conspicuously margined with fuscous (Fig. 54); hind tibiae about six times as long as hind tarsi; apterous forms with setae on body enlarged at tips (Fig. 333).....*Myzocallis ononidis* (Kaltenbach) p. 258
3. Large greenish species; cornicles long and slender (Fig. 129), longer than width of head through the eyes; cauda elongate (Fig. 181).....*Macrosiphum pisi* (Kaltenbach) p. 317
- Small yellowish-green, brownish or reddish species; cornicles short and stout (Fig. 130), much shorter than width of head through eyes; cauda short (Fig. 202).....4
4. Beak long, reaching to or beyond base of middle legs; fifth antennal segment usually with secondary sensoria; stigma rather broad, apex not especially acute.....*Aphis crataegifoliae* Fitch p. 190
- Beak short, seldom reaching to base of middle legs; fifth antennal segment without secondary sensoria; stigma rather narrow, apex rather acute.....*Aphis bakeri* Cowen p. 181

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON ORNAMENTAL SHRUBS IN ILLINOIS

1. On stems and leaves of elder berry (*Sambucus*); a medium-size blackish or bluish aphid with a greenish tinge; cornicles about as long as width of head through eyes.....*Aphis sambucifoliae* Fitch p. 218
- On stems near base of snowberry and coralberry (*Symphoricarpos*); a large aphid covered with conspicuous white woolly secretion; cornicles short, shorter than length of basal portion of sixth antennal segment.....*Amphiceridus pulverulens* (Gillette) p. 160
- On leaves of nine-bark (*Physocarpus*); a small dark brownish aphid; cornicles short, much shorter than width of head through eyes; third, fourth, and fifth antennal segments with numerous secondary sensoria.....*Aphis neilliae* Oestlund p. 205
- On twigs and leaves of buttonbush (*Cephalanthus*); a small greenish or reddish-brown aphid, somewhat pruinose; cornicles short, much shorter than width of head through eyes.....*Aphis cephalanthi* Thomas p. 185
- On stems and leaves of barberry (*Berberis*); a small yellowish aphid; cornicles about as long as width of head through eyes, apical portions distinctly swollen (Fig. 148).....*Rhopalosiphum berberidis* (Kaltenbach) p. 235
- On stems and leaves of *Evonymus*; a small blackish or bluish aphid, often with white dorsal spots; cornicles much shorter than width of head through eyes.....*Aphis rumicis* Linnaeus p. 215
- On twigs and leaves of buckthorn (*Rhamnus*), often causing them to curl; a very small greenish or blackish aphid; cornicles shorter than width of head through eyes.....*Aphis rhamni* Fonscolombe p. 214
- On leaves of bush honeysuckle (*Diervilla*); a small yellowish or greenish aphid with dark cornicles; cornicles short, much shorter than width of head through eyes.....*Aphis gossypii* Glover p. 195
- On species and varieties of roses (*Rosa*); (see key of aphids likely to occur on garden flowers)..... p. 379
- On sumach (*Rhus*)2
- On hawthorn (*Crataegus*)3
- On snowball, highbush cranberry, and other shrubs belonging to the same genus (*Viburnum*).....8
- On privet (*Ligustrum*)11
- On honeysuckle (*Lonicera*)13
- On dogwood (*Cornus*)15
- On ornamental currant (*Ribes*).....18
- On witch-hazel (*Hamamelis*)19
- On hazelnut (*Corylus*)20
- On *Spiraea*21
- On *Elacagnus*23
- On *Prunus*24
2. Cornicles present, swollen at apices (Fig. 148), about as long as width of head through eyes; forming dense colonies on undersides of leaves and stems; a medium-size, reddish-brown species.....*Rhopalosiphum rhois* Monell p. 240
- Cornicles absent; forming bag-like galls on upper surfaces of leaves; a very small species.....*Melaphis rhois* (Fitch) p. 359
3. Cornicles absent or not protruding conspicuously from abdomen.....4
- Cornicles present and conspicuously protruding from abdomen.....5
4. Antennae with annular secondary sensoria, appearing notched or corrugated from a side view (Fig. 223); in flocculent colonies in curled leaves.....*Prociphilus corrugatus* (Sirrime) p. 370

- Antennae with oval or oval-transverse secondary sensoria, appearing more cylindrical from a side view (Fig. 226); in flocculent colonies on undersides of stems and branches (Fig. 42) *Eriosoma crataegi* (Oestlund) p. 351
- 5. Cornicles longer than width of head through eyes; a large yellowish aphid *Macrosiphum crataegi* (Monell) p. 304
- Cornicles shorter than width of head through eyes; medium-sized aphids 6
- 6. Cauda short and rounded; secondary sensoria numerous on fourth and fifth antennal segments; head and thorax in life with a pink or crimson tinge *Aphis crataegifoliae* Fitch p. 190
- Cauda elongate; secondary sensoria few or wanting on fourth and fifth antennal segments; head and thorax in life brown or greenish brown, never pink or crimson 7
- 7. Cornicles not swollen nor constricted before apices (Fig. 130) *Aphis pomi* DeGeer p. 210
- Cornicles slightly swollen and constricted before apices (Fig. 134) *Rhopalosiphum prunifoliae* (Fitch) p. 239
- 8. Apterous forms colored a pale bluish green, covered with a whitish powdery secretion; causing a severe curling of the leaves or pseudogall (Fig. 28) *Aphis viburnicola* Gillette p. 223
- Apterous forms yellowish green, brown, or black, never covered with whitish powdery secretion; on stems and leaves and not causing a pseudogall 9
- 9. Apterous forms yellowish-green, alates with dark spots along sides of abdomen; third antennal segment usually with less than ten secondary sensoria *Aphis pomi* DeGeer p. 210
- Apterous forms brownish or bluish black; third antennal segment usually with more than twelve secondary sensoria 10
- 10. A bluish black species, often with white spots on dorsum; apices of hind tibiae dark, sharply contrasting with lighter basal portion *Aphis rumicis* Linnaeus p. 215
- A uniformly brownish species; hind tibiae more uniformly brown *Aphis viburniphila* Patch p. 224
- 11. Abdomen colored shades of green or pink 12
- Abdomen bluish black, often with white dorsal spots *Aphis rumicis* Linnaeus p. 215
- 12. Cornicles cylindrical, much longer than width of head through eyes, reticulated at apex (Fig. 111); dorsum of abdomen uniformly some shade of green or pink; antennal tubercles poorly developed (Fig. 84) *Macrosiphum gei* (Koch) p. 306
- Cornicles with apical portion often slightly swollen, about as long as width of head through eyes, not reticulated at apex (Fig. 129); dorsum of abdomen often with a large dark dorsal patch on a yellowish green background; antennal tubercles well developed (Fig. 86) *Myzus persicae* (Sulzer) p. 339
- 13. Cornicles absent; causes leaves to curl *Gypsoaphis oestlundii* Hottes p. 167
- Cornicles present and conspicuous 14
- 14. Longitudinal vein of hind wing once-forked, the second branched but partially developed (Fig. 89); fifth antennal segment about twice as long as hind tarsi; causes leaves to curl *Alphitoaphis lonicericola* (Williams) p. 175
- Longitudinal vein of hind wing twice-forked (Fig. 93); fifth antennal segment and hind tarsi about equal in length; on leaves and flower bracts *Rhopalosiphum melliferum* (Hottes) p. 238
- 15. Terminal filament much shorter than basal portion of sixth segment; cornicles on cone-shaped areas (Fig. 155) *Anoecia quercus* (Fitch) p. 152
- Terminal filament two or three times as long as basal portion of sixth segment; cornicles cylindrical (Fig. 133), prominently projecting from abdomen 16

16. Apterous forms and abdomen of alate forms greenish; cornicles but slightly shorter than terminal filaments, secondary sensoria on third antennal segment numbering over twenty; often causing leaves of terminal branches to curl (Fig. 21)..... *Aphis helianthi* Monell p. 196
- Apterous forms and abdomen of alate forms blackish or brownish; in cornicles about one-half or less as long as terminal filament; secondary sensoria on third antennal segment numbering under twenty; on stems and under sides of leaves, sometimes causing the latter to curl..... 17
17. Cornicles much longer than basal portion of sixth antennal segment; a blackish form on the upper and lower sides of leaves *Aphis cornifoliae* Fitch p. 189
- Cornicles no longer than basal portion of sixth antennal segment; a reddish-brown form on stems near tips..... *Aphis caliginosa* n. sp. p. 182
18. Cauda elongate; secondary sensoria lacking or rare on fourth and fifth antennal segments; apterous forms without knobbed setae (Fig. 324); alates with dorsum of abdomen uniformly yellowish green *Macrosiphum ribiellum* Davis p. 319
- Cauda short and blunt; secondary sensoria numerous on fourth and fifth antennal segments; apterous forms with knobbed setae (Fig. 320); alates with a dark dorsal patch on abdomen *Capitophorus ribis* (Linnaeus) p. 290
19. Antennae with three segments; causing small conical galls on upper surfaces of leaves..... *Hormaphis hamamelidis* (Fitch) p. 376
- Antennae with five segments; causing a many-spined bud gall (Fig. 40)..... *Hamamelistes spinosus* Shimer p. 375
20. Cornicles very long and conspicuous, much longer than width of head between eyes; a large green and dark-colored species, black cornicles contrasting with abdomen..... *Macrosiphum coryli* Davis p. 303
- Cornicles very short, much shorter than width of head through eyes, about as long as hind tarsi; a medium-size yellowish species, cornicles concolorous with abdomen..... *Myzocallis coryli* (Goeze) p. 257
21. Abdomen essentially black or bluish-black and often with dorsal white spots; secondary sensoria on third antennal segment usually more than fourteen in number..... *Aphis rumicis* Linnaeus p. 215
- Abdomen some shade of green or pinkish-brown; secondary sensoria on third antennal segment rarely exceeding ten in number 22
22. Abdomen of alates and apterous forms yellowish-green, not pruinose; cornicles much longer than hind tarsi; recorded from several species and varieties of *Spiraea* as well as numerous other hosts..... *Aphis pomi* DeGeer p. 210
- Abdomen of alates and apterous forms pinkish-green or reddish-brown, slightly pruinose; cornicles about as long as hind tarsi; recorded only from the meadowsweet (*Spiraea salicifolia*)... *Aphis spiraeophila* Patch p. 222
23. Cornicles with apical portion slightly swollen..... *Capitophorus gillettei* Theobald p. 284
- Cornicles cylindrical..... *Capitophorus flaveolus* (Walker) p. 282
24. Hind wings with longitudinal vein once-forked (Fig. 89); apterous forms and abdomen of alates a reddish brown..... *Hysteroneura setariae* (Thomas) p. 232
- Hind wings with longitudinal vein twice-forked (Fig. 91); apterous forms and abdomen of alates some shade of green..... *Aphis pomi* DeGeer p. 210

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON
PEACH, PLUM, OR CULTIVATED CHERRY IN ILLINOIS

1. Cornicles very short, about as long as hind tarsi; secondary sensoria numerous on fourth antennal segment.....2
- Cornicles long, at least several times as long as hind tarsi; secondary sensoria lacking or rare on fourth antennal segment.....3
2. Cornicles with a distinct flange (Fig. 137); cauda short and rounded; dorsum of abdomen with dark markings on a yellowish or greenish background; apterous forms without a white woolly secretion; tightly curling leaves at ends of branches of peach and plum (Fig. 25).....*Aphis padi* Linnaeus p. 209
- Cornicles without a flange (Fig. 142); cauda elongate; dorsum of abdomen uniformly yellowish or greenish; apterous forms with a white woolly secretion; on lower sides of leaves and succulent stems of plum.....*Hyalopterus pruni* (Geoffroy) p. 232
3. Hind wings with longitudinal vein with one branch (Fig. 89); antennal tubercles not well developed (Fig. 79).....*Hysteronura setariae* (Thomas) p. 232
- Hind wings with longitudinal vein with two branches (Fig. 91); antennal tubercles well developed (Fig. 86).....4
4. Almost uniformly reddish brown; cornicles distinctly imbricated throughout; partial to cherry (Fig. 39).....*Myzus cerasi* (Fabricius) p. 335
- Yellowish-green with dark markings; cornicles not distinctly imbricated throughout; partial to peach, causing leaves on shoots to curl.....*Myzus persicae* (Sulzer) p. 339

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON
TRUCK CROPS IN ILLINOIS

1. Cornicles much longer than width of head through the eyes.....2
- Cornicles not longer than width of head through eyes.....3
2. Apical portion of cornicles reticulated (Fig. 111); species partial to potatoes and not likely to occur in numbers on other truck crops.....*Macrosiphum gei* (Koch) p. 306
- Apical portion of cornicles not reticulated (Fig. 129); species partial to peas and not likely to occur in numbers on other truck crops.....*Macrosiphum pisi* (Kaltenbach) p. 317
3. Abdomen entirely brown, bluish-black, or black, and dorsum often with small white spots; cauda and cornicles concolorous with abdomen; likely to be found on any truck crop.....*Aphis rumicis* Linnaeus p. 215
- Abdomen mostly shades of green or yellow; cauda and cornicles sometimes contrasting with abdomen.....4
4. Cornicles approximately as long as width of head through eyes; dorsum of abdomen with a large solid brownish patch anterior to cornicles; likely to occur on any truck crop.....*Myzus persicae* (Sulzer) p. 339
- Cornicles much shorter than width of head through eyes; dorsum of abdomen without a large solid brownish patch anterior to cornicles, although spots and transverse bars may be present.....5
5. Third antennal segment as long as, or longer than, combined length of fourth, fifth, and basal portion of sixth; apterous forms thickly covered with whitish powder; partial to cruciferous plants, often causing the leaves to blister or curl.....*Brevicoryne brassicae* (Linnaeus) p. 228
- Third antennal segment shorter than combined length of fourth, fifth, and basal portion of sixth; apterous forms not covered with whitish powder.....6

6. Veins of wings conspicuously outlined with fuscous; fourth antennal segment with four or more secondary sensoria; partial to cruciferous plants. *Rhopalosiphum pseudobrassicæ* (Davis) p. 240
- Veins of wings normal, not conspicuously outlined with fuscous; fourth antennal segment with secondary sensoria lacking, rarely one or two; partial to cucurbitaceous truck crops.....
.....*Aphis gossypii* Glover p. 195

KEY TO THE SPECIES OF PLANT LICE LIKELY TO OCCUR ON
PLANTS USED AS VINES IN ILLINOIS

1. Cornicles absent or inconspicuous.....2
- Cornicles present and conspicuous (Fig. 100).....3
2. Alate and apterous forms essentially brownish, usually covered with a white flocculent secretion; sixth antennal segment with terminal filament much shorter than basal portion (Fig. 244); on stems and leaves of smilax (Fig. 48).....
.....*Neoprociphilus attenuatus* (O. & S.) p. 362
- Alate and apterous forms essentially greenish white, usually covered with a white flocculent secretion; sixth antennal segment with terminal filament much longer than basal portion (Fig. 248); on leaves and terminal shoots of honeysuckle.....
.....*Gypsoaphis oestlundii* Hottes p. 167
3. Abdomen essentially yellow or yellowish-green with some dark markings.....4
- Abdomen dark-brown, reddish-brown, or black.....5
4. Antennal tubercles with a finger-like inward projecting protrusion (Fig. 85); cornicles slender and smooth; many irregularly distributed secondary sensoria on third antennal segment; on hop.....*Phorodon humuli* (Schrank) p. 345
- Antennal tubercles without a projection (Fig. 80); cornicles stout and imbricated; secondary sensoria fewer and arranged more in a straight row; on angle-pod and morning glory.....
.....*Aphis nerii* Fonscolombe p. 206
5. Black or bluish-black, apterous forms with white spots on dorsum; on bittersweet.....*Aphis rumicis* Linnaeus p. 215
- Alate and apterous forms essentially a uniform dark or reddish brown.....6
6. Third, fourth and fifth antennal segments of winged females of about the same length; on Boston ivy and Virginia creeper..
.....*Aphis folsomii* Davis p. 193
- Third antennal segment of winged females much longer than fourth or fifth; on wild and cultivated grapes.....
.....*Aphis illinoisensis* Shimer p. 198

HOST INDEX

In this index are summarized all of our records of associations between plants and plant lice in Illinois. Under the scientific names of the plants are given lists of the species of plant lice found attacking them. The common names of many plants are inserted for convenience and references given to their scientific names.

The botanical and common names used in this paper are in accordance with the seventh edition of "*Gray's New Manual of Botany*," except for the cultivated plants and some not included in Gray's Manual because of their extralimital origins. For the cultivated plants we have followed the nomenclature of the "*Manual of Cultivated Plants*," by L. H. Bailey (1924). For other plants not covered by these references we have followed the "*Dictionary of Plant Names*," by H. L. Gerth van Wijk (1911).

- Acer Negundo*
Aphis rumicis L.
Aphis spiraeicola Patch
Periphyllus negundinis (Thomas)
Acer saccharinum
Clavigerus smithiae (Monell)
Drepanaphis acerifoliae (Thomas)
Drepanaphis monelli (Davis)
Neoprociphilus aceris (Monell)
Acer saccharum
Aphis rumicis L.
Clavigerus smithiae (Monell)
Drepanaphis acerifoliae (Thomas)
Drepanaphis keshenae Granovsky
Drepanaphis monelli (Davis)
Drepanaphis sp.
Myzocallis ononidis (Kalt.)
Myzocallis punctata (Monell)
Neoprociphilus aceris (Monell)
Periphyllus lyropictus (Kessler)
Shenahweum minutum (Davis)
Achillea Millefolium
Capitophorus patonkus H. & F.
Macrosiphum ambrosiae (Thomas)
Macrosiphum frigidicola (G. & P.)
Macrosiphum tapuskae H. & F.
Actinomeris alternifolia
Macrosiphum ambrosiae (Thomas)
Macrosiphum ruralis H. & F.
Aesculus glabra
Drepanaphis monelli (Davis)
Alder—see *Alnus*
Alfalfa—see *Medicago*
Alkanet—see *Anchusa*
Alnus sp.
Myzus alnifoliae (Fitch)
Prociphilus tessellata (Fitch)
Alum-root—see *Heuchera*
Amaranth—see *Amaranthus*
Amaranthus paniculatus
Macrosiphum gei (Koch)
Amaranthus retroflexus
Macrosiphum gei (Koch)
Amaranthus sp.
Macrosiphum gei (Koch)
Macrosiphum schranki Theobald
Ambrosia trifida
Macrosiphum ambrosiae (Thomas)
Ambrosia sp.
Macrosiphum ambrosiae (Thomas)
Macrosiphum rudbeckiae (Fitch)
Amelanchier sp.
Prociphilus corrugatus (Sirrine)
American aspen—see *Populus tremuloides*
American elm—see *Ulmus americana*
Amphicarpa monoica
Microparsus variabilis Patch
Amsonia Tabernaemontana
Aphis rhamni Fonsc.
Anchusa myosotidiflora
Aphis gossypii Glover
Myzus circumflexus (Buckton)
Angelica sp.
Aphis signatis H. & F.
Angle-pod—see *Gonolobus*
Anthemis cotula
Macrosiphum gei (Koch)
Apium graveolens var. *dulce*
Aphis gossypii Glover
Macrosiphum gei (Koch)
Myzus lactucae (Schrank)
Myzus persicae (Sulz.)
Apocynum sp.
Aphis asclepiadis Fitch
Aphis spiraeicola Patch
Macrosiphum gei (Koch)

- Apple—see *Pyrus Malus*
Aquilegia canadensis
 Aphis spiraeicola Patch
 Myzus essigi G. & P.
 Myzus persicae (Sulz.)
Arabis Drummondii
 Aphis gossypii Glover
Arctium minus
 Aphis rumicis L.
Arctium sp.
 Myzus persicae (Sulz.)
Arctostaphylos Uva-ursi
 Amphorophora nervata (Gill.)
 Tamalia coweni (Ckll.)
 Arrow-wood—see *Viburnum*
Artemisia abrotanum
 Macrosiphum frigidicola (G. & P.)
Artemisia pedemontana
 Macrosiphum frigidicola (G. & P.)
Artemisia sp.
 Macrosiphum gei (Koch)
 Macrosiphum ludoviciana (Oestl.)
Aruncus sylvestris
 Macrosiphum pseudorosae Patch
Asclepias curassavica
 Aphis nerii Fonsc.
Asclepias incarnata
 Aphis nerii Fonsc.
Asclepias sp.
 Aphis asclepiadis Fitch
 Aphis gossypii Glover
 Aphis rumicis L.
 Aphis spiraeicola Patch
 Macrosiphum gei (Koch)
 Myzocallis asclepiadis (Monell)
 Myzocallis punctata (Monell)
 Myzus persicae (Sulz.)
 Ash—see *Fraxinus*
 Aspen—see *Populus*
Aspidium sp.
 Macrosiphum adianti (Oestl.)
Asplenium Filix-femina
 Macrosiphum ptericolens Patch
Asplenium sp.
 Amphorophora laingi Mason
 Idiopterus nephrolepidis Davis
 Macrosiphum adianti (Oestl.)
 Macrosiphum ptericolens Patch
Aster novae-angliae
 Macrosiphum anomalae H. & F.
Aster sp.
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum anomalae H. & F.
 Macrosiphum erigeronensis
 (Thomas)
 Macrosiphum gravicornis Patch
Avena sativa
 Aphis maidi-radici Forbes
 Forda olivacea Rohwer
 Geocica squamosa Hart
 Macrosiphum granarium (Kby.)
 Rhopalosiphum prunifoliae (Fitch)
 Toxoptera graminum (Rond.)
 Avens—see *Geum*
 Barberry—see *Berberis*
 Basswood—see *Tilia americana*
 Bearberry—see *Arctostaphylos*
 Bedstraw—see *Galium*
 Beech—see *Fagus grandifolia*
 Beet—see *Beta vulgaris*
 Beggar-ticks—see *Bidens vulgata*
 Berberis Thunbergii minor
 Rhopalosiphum berberidis (Kalt.)
 Bergamot—see *Monarda fistulosa*
 Beta vulgaris
 Myzus persicae (Sulz.)
Betula alba var. *papyrifera*
 Calaphis betulae (Fitch)
 Calaphis betulella Walsh
 Euceraphis betulae (Koch)
 Hamamelistes spinosus Shimer
 Neosymydobius americanus
 (Baker)
Betula nigra
 Calaphis betulella Walsh
 Hamamelistes spinosus Shimer
 Pemphigus ephemeratus H. & F.
Betula pendula
 Calaphis betulae (Fitch)
 Hamamelistes spinosus Shimer
 Neosymydobius annulatus (Koch)
Betula pumila
 Cepigillettea betulae foliae Gra-
 novsky
 Hamamelistes spinosus Shimer
Bidens vulgata
 Aphis coreopsidis (Thomas)
 Macrosiphum chrysanthemi
 (Oestl.)
Bidens sp.
 Aphis ageratoidis Oestl.
 Aphis coreopsidis (Thomas)
 Macrosiphum chrysanthemi Oestl.
 Pemphigus tartareus H. & F.
Bindweed—see *Convolvulus*
Birch—see *Betula*
Bittersweet—see *Celastrus* and *Solanum Dulcamara*
Blackberry—see *Rubus*
Black cherry—see *Prunus serotina*
Black currant—see *Ribes nigrum*
Black-eyed susan—see *Rudbeckia hirta*
Black gum—see *Nyssa sylvatica*
Black jack—see *Quercus marilandica*
Black larch—see *Larix laricina*
Black locust—see *Robinia Pseudo-Acacia*
Black mustard—see *Brassica nigra*
Black oak—see *Quercus velutina*
Black snakeroot—see *Sanicula*
Black walnut—see *Juglans nigra*
Black willow—see *Salix nigra*
Blazing star—see *Liatris squarrosa*
Blephilia hirsuta
 Aphis agertoidis Oestl.

- Bloodflower—see *Asclepias curasavica*
 Bloodroot—see *Sanguinaria canadensis*
 Blue beech—see *Carpinus caroliniana*
 Blueberry—see *Vaccinium*
 Boston ivy—see *Parthenocissus tricuspidata*
 Bottle grass—see *Setaria viridis*
 Box elder—see *Acer Negundo*
 Bramble—see *Rubus*
Brasenia Schreberi
 Aphis maidis Fitch
Brassica nigra
 Aphis maidi-radici Forbes
Brassica oleracea
 Brevicoryne brassicae (L.)
 Myzus persicae (Sulz.)
 Rhopalosiphum pseudobrassicae (Davis)
Brassica rapa
 Myzus persicae (Sulz.)
 Rhopalosiphum pseudobrassicae (Davis)
Brassica sp.
 Myzocallis asclepiadis (Monell)
 Myzus persicae (Sulz.)
 Rhopalosiphum pseudobrassicae (Davis)
Brickellia grandiflora
 Aphis ageratoidis Oestl.
 Bristly foxtail grass—see *Setaria*
 Broom corn—see *Holcus Sorghum* var. *technicus*
 Buckeye—see *Aesculus*
 Buckthorn—see *Rhamnus*
 Buffalo currant—see *Ribes odoratum*
 Bull thistle—see *Cirsium lanceolatum*
 Burdock—see *Arctium*
 Bur marigold—see *Bidens*
 Bur oak—see *Quercus macrocarpa*
 Burning bush—see *Evonymus atropurpureus*
 Bush honeysuckle—see *Diervilla*
 Buttercup—see *Ranunculus*
 Butter-weed—see *Erigeron canadensis* and *Senecio glabellus*
 Buttonbush—see *Cephalanthus*
 Button snakeroot—see *Liatris*
 Buttonwood—see *Platanus occidentalis*
 Cabbage—see *Brassica oleracea*
 Calendula sp.
 Macrosiphum gei (Koch)
 Canada plum—see *Prunus nigra*
 Canada thistle—see *Cirsium arvense*
 Canoe birch—see *Betula pendula* and *Betula alba* var. *papyrifera*
 Cape primrose—see *Streptocarpus*
Capsella Bursa-pastoris
 Forda occidentalis Hart
 Geonica squamosa Hart
Capsicum dulce
 Aphis gossypii Glover
 Macrosiphum gei (Koch)
 Myzus persicae (Sulz.)
Carex sp.
 Aphis maidis Fitch
 Aphis rumicis L.
 Iziphyia flabella (Sanborn)
 Macrosiphum pisi (Kalt.)
 Rhopalosiphum enigmae var. *parvae* H. & F.
 Rhopalosiphum melliferum (Hottes)
 Rhopalosiphum prunifoliae (Fitch)
 Saltusaphis elongata Baker
 Saltusaphis wanica H. & F.
 Sipha flava (Forbes)
 Thripsaphis ballii (Gill.)
 Thripsaphis producta Gill.
 Thripsaphis verrucosa Gill.
 Toxoptera graminum (Rond.)
 Carnation—see *Dianthus*
Carpinus caroliniana
 Macrosiphum carpinicolens Patch
 Carrot—see *Daucus Carota*
Carya illinoensis
 Longistigma caryae (Harris)
 Monellia caryella (Fitch)
 Monellia nigropunctata Granovsky
Carya ovata
 Monellia caryella (Fitch)
 Monellia costalis (Fitch)
 Monellia nigropunctata Granovsky
Carya sp.
 Melanocallis fumipennella (Fitch)
 Monellia caryae (Monell)
 Monellia caryella (Fitch)
 Monellia costalis (Fitch)
 Monellia nigropunctata Granovsky
 Myzocallis discolor (Monell)
 Myzocallis punctata (Monell)
 Myzocallis walshii (Monell)
 Tuberculatus punctatellus (Fitch)
Castalia sp.
 Rhopalosiphum nymphaeae (L.)
Castanea dentata
 Anoechia oenotherae Wilson
 Calaphis castaneae (Fitch)
 Longistigma caryae (Harris)
Catalpa speciosa
 Aphis spiraeicola Patch
 Myzus persicae (Sulz.)
 Catawba tree—see *Catalpa*
 Cat brier—see *Smilax*
 Cat mint—see *Nepeta*
 Catnip—see *Nepeta*
 Cat spruce—see *Picea canadensis*
 Cat-tail—see *Typha latifolia*
 Cedar—see *Juniperus virginiana*

- Celastrus scandens*
 Aphis rumicis L.
 Aphis spiraeicola Patch
 Macrosiphum pisi (Kalt.)
Celery—see *Apium*
Cephalanthus occidentalis
 Aphis cephalanthi Thomas
Chamomile—see *Anthemis*
Chenopodium album
 Hyalopterus atriplicis (L.)
Chenopodium sp.
 Aphis gossypii Glover
 Macrosiphum gei (Koch)
 Myzus persicae (Sulz.)
Cherry—see *Prunus*
Chestnut—see *Castanea*
Chokeberry—see *Pyrus arbutifolia*
 var. *atropurpurea*
Choke cherry—see *Prunus virginiana*
Chrysanthemum sp.
 Macrosiphum sanborni Gill.
 Myzus circumflexus (Buckton)
 Rhopalosiphum rufomaculatum
 (Wilson)
Cineraria—see *Senecio cruentus*
Cinquefoil—see *Potentilla*
Cirsium arvense
 Aphis rumicis L.
Cirsium lanceolatum
 Aphis carduella Walsh
 Aphis cardui L.
 Aphis rumicis L.
 Capitophorus flaveolus (Walker)
Cirsium sp.
 Capitophorus flaveolus (Walker)
 Macrosiphum ambrosiae (Thomas)
Clearweed—see *Pilea*
Climbing bittersweet—see *Celastrus*
Climbing dogbane—see *Trachelospermum*
Clotbur—see *Xanthium*
Clover—see *Melilotus* and *Trifolium*
Coccoloba laurifolia
 Aphis gossypii Glover
Coccoloba flendana
 Aphis gossypii Glover
Cocklebur—see *Xanthium*
Columbine—see *Aquilegia*
Cone-flower—see *Rudbeckia*
Conioselinum chinense
 Rhopalosiphum melliferum
 (Hottes)
Convolvulus sepium
 Aphis nerii Fonsc.
Convolvulus sp.
 Aphis nerii Fonsc.
 Aphis spiraeicola Patch
 Macrosiphum gei (Koch)
 Myzus persicae (Sulz.)
Coral-berry—see *Symphoricarpos orbiculatus*
Corn—see *Zea Mays*
Cornel—see *Cornus*
Cornelian cherry—see *Cornus mas*
Cornus mas
 Aphis helianthi Monell.
Cornus stolonifera
 Aphis cornifoliae Fitch
 Aphis helianthi Monell.
Cornus stricta
 Aphis spiraeicola Patch
Cornus sp.
 Anoecia querci (Fitch)
 Aphis caliginosa H. & F.
 Aphis cornifoliae Fitch
 Aphis helianthi Monell
 Aphis spiraeicola Patch
Corylus americana
 Macrosiphum coryli Davis
 Myzocallis coryli (Goeze)
Cotton—see *Gossypium*
Cotton-wood—see *Populus deltoides*
Cowslip—see *Dodecatheon*
Cranberry—see *Vaccinium*
Cranberry-tree—see *Viburnum opulus* var. *americanum*
Cranesbill—see *Geranium*
Crataegus Crus-galli
 Prociphilus corrugatus (Sirrine)
 Rhopalosiphum prunifoliae (Fitch)
Crataegus tomentosa
 Macrosiphum crataegi (Monell)
Crataegus sp.
 Aphis crataegifoliae Fitch
 Aphis pomi DeGeer
 Eriosoma crataegi (Oestl.)
 Macrosiphum crataegi (Monell)
 Rhopalosiphum prunifoliae (Fitch)
 Tuberculatus ulmifolii (Monell)
Crocus sp.
 Aphis gossypii Glover
Crowfoot—see *Ranunculus*
Cryptotaenia canadensis
 Macrosiphum gei (Koch)
 Rhopalosiphum melliferum
 (Hottes)
Cucumber—see *Cucumis sativus*
Cucumis melo
 Aphis gossypii Glover
Cucumis sativus
 Aphis gossypii Glover
 Aphis spiraeicola Patch
Cup plant—see *Silphium perfoliatum*
Cucurbita maxima
 Aphis gossypii Glover
 Macrosiphum gei (Koch)
Cucurbita Pepo
 Aphis gossypii Glover
 Macrosiphum gei (Koch)
Currant—see *Ribes*
Cut-leaf birch—see *Betula pendula*
Cyclamen indicum
 Myzus persicae (Sulz.)
Cycloloma atriplicifolium
 Macrosiphum gei (Koch)
Dahlia sp.
 Aphis rumicis L.

- Daisy—see *Chrysanthemum*
 Daisy fleabane—see *Erigeron annuus*
 Dandelion—see *Taraxacum*
Daucus carota
 Aphis tulipae Fonsc.
 Rhopalosiphum melliferum
 (Hottes)
Delphinium tricornes
 Aphis rociadae Ckll.
Desmodium sp.
 Microparsus variabilis Patch
Dianthus sp.
 Aphis rumicis L.
 Myzus persicae (Sulz.)
Diervilla sp.
 Aphis gossypii Glover
Dock—see *Rumex*
Dodecatheon Meadia
 Aphis spiraeicola Patch
Dogbane—see *Apocynum*
Dog fennel—see *Anthemis cotula*
Dogwood—see *Cornus*
Downy poplar—see *Populus heterophylla*
Duck's-meat—see *Lemna*
Duckweed—see *Lemna*
- Easter lily*—see *Lilium*
Egg-plant—see *Solanum Melongena*
Eichhornia sp.
 Rhopalosiphum nymphaeae (L.)
Elaeagnus sp.
 Capitophorus flaveolus (Walker)
 Capitophorus gillettei Theobald
Elder—see *Sambucus*
Elecampane—see *Inula*
Eleusine indica
 Anoecia querci (Fitch)
Elm—see *Ulmus*
Elymus sp.
 Periphyllus negundinis (Thomas)
Erigeron annuus
 Macrosiphum erigeronensis
 (Thomas)
Erigeron canadensis
 Macrosiphum erigeronensis
 (Thomas)
 Prociphilus erigeronensis
 (Thomas)
Erigeron philadelphicus
 Anoecia querci (Fitch)
 Aphis maidi-radici Forbes
 Geocia squamosa Hart
 Macrosiphum erigeronensis
 (Thomas)
 Macrosiphum gravicornis Patch
 Pemphigus brevicornis (Hart)
Erigeron sp.
 Anoecia querci (Fitch)
 Macrosiphum erigeronensis
 (Thomas)
 Macrosiphum gravicornis Patch
Eupatorium purpureum var. *maculatum*
 Aphis vernoniae Thomas
Eupatorium urticaefolium
 Aphis ageratoides Oestl.
 Aphis coreopsidis (Thomas)
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum chrysanthemi
 (Oestl.)
 Macrosiphum gei (Koch)
 Macrosiphum rudbeckiae (Fitch)
Euphorbia marginata
 Macrosiphum gei (Koch)
Euphorbia sp.
 Aphis pulchella H. & F.
 Macrosiphum gei (Koch)
Evening primrose—see *Oenothera biennis*
Everlasting pea—see *Lathyrus*
Evonymus alatus
 Aphis rumicis L.
Evonymus atropurpureus
 Aphis rumicis L.
- Fagus grandifolia*
 Prociphilus imbricator (Fitch)
 Phyllaphis fagi (L.)
Fern—see *Aspidium*, *Asplenium*, and *Nephrolepis*
Fetid Buckeye—see *Aesculus glabra*
Figwort—see *Scrophularia*
Filbert—see *Corylus*
Fir—see *Pinus sylvestris*
Fleabane—see *Erigeron*
Fleur-de-lis—see *Iris*
Flowering almond—see *Prunus japonica*
Flowering cherry—see *Prunus triloba*
Forget-me-not—see *Myosotis*
Foxtail—see *Setaria glauca*
Fragaria sp.
 Aphis forbesi Weed
 Capitophorus fragaefolii (Ckll.)
 Capitophorus minor (Forbes)
Fraxinus pennsylvanica var. *lanceolata*
 Prociphilus fraxinifolii (Riley)
Fraxinus americana
 Prociphilus fraxinifolii (Riley)
Fraxinus sp.
 Prociphilus fraxinifolii (Riley)
Fuchsia sp.
 Myzus circumflexus (Buckton)
- Galium* sp.
 Aphis rumicis L.
 Myzus cerasi (F.)
 Rhopalosiphum nymphaeae (L.)
Garland flower—see *Hedychium coronarium*
Gaura biennis
 Macrosiphum pseudorosae Patch
Gaura sp.
 Macrosiphum pseudorosae Patch
Geranium maculatum
 Macrosiphum geranii (Oestl.)

- Geranium sp., wild
 Macrosiphum geranii (Oestl.)
 Geranium sp., cultivated
 Myzus circumflexus (Buckton)
 Gerardia pedicularia
 Aphis rumicis var. *gerardiae*
 Geum canadense
 Amphorophora rossi H. & F.
 Macrosiphum pseudorosae Patch
 Ginger-lily—see *Hedychium*
 Goat's beard—see *Aruncus*
 Golden alexanders—see *Zizia aurea*
 Golden-glow—see *Rudbeckia laciniata* var. *hortensia*
 Golden-rod—see *Solidago*
 Gonolobus laevis
 Aphis nerii Fonsc.
 Gooseberry—see *Ribes*
 Goosefoot—see *Chenopodium*
 Goose grass—see *Eleusine*
 Gossypium sp.
 Aphis gossypii Glover
 Gourd—see *Cucurbita* and *Lagenaria vulgaris*
 Grape—see *Vitis*
 Grass—see *Setaria*, *Eleusine*, *Elymus*, *Panicum*, and *Poa*.
 Grasses—(unidentified)
 Amphorophora singularis H. & F.
 Anoecia querci (Fitch)
 Brachycolus tritici Gill.
 Colopha graminis (Monell)
 Colopha ulmicola (Fitch)
 Forda occidentalis Hart
 Forda olivacea Rohwer
 Geioica squamosa Hart
 Prociphilus erigeronensis (Thomas)
 Rhopalosiphum prunifoliae (Fitch)
 Sipha flava (Forbes)
 Great ragweed—see *Ambrosia trifida*
 Green Amaranth—see *Amaranthus retroflexus*
 Green ash—see *Fraxinus pennsylvanica* var. *lanceolata*
 Green brier—see *Smilax*
 Green foxtail grass—see *Setaria viridis*
 Groundsel—see *Senecio*
 Hackmatack—see *Larix laricina*
 Hamamelis virginiana
 Hamamelistes spinosus Shimer
 Hamamelis sp.
 Hamamelistes spinosus Shimer
 Hormaphis hamamelidis (Fitch)
 Hard maple—see *Acer saccharum*
 Hawkweed—see *Hieracium*
 Hawthorn—see *Crataegus*
 Hazelnut—see *Corylus americana*
 Heart's ease—see *Viola tricolor* and *Viola*
 Hedge bindweed—see *Convolvulus sepium*
Hedychium coronarium
 Pentalonia nigronervosa Coquerel
Helenium autumnale
 Aphis gossypii Glover
 Aphis vernoniae Thomas
 Macrosiphum tardae H. & F.
Helianthus sp.
 Aphis debilicornis G. & P.
 Aphis helianthi Monell
 Aphis rumicis L.
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum gei (Koch)
 Macrosiphum illini H. & F.
 Macrosiphum illini var. *crudae* H. & F.
 Macrosiphum illini var. *sangamonensis* H. & F.
 Macrosiphum rudbeckiae Fitch
 Macrosiphum ruralis H. & F.
 Myzus persicae (Sulz.)
Helichrysum bracteatum
 Aphis spiraeicola Patch
 Hemlock parsley—see *Conioselinum*
 Heuchera sp.
 Myzus heucherae (Thomas)
 Hibiscus sp.
 Aphis rhamni Fonsc.
 Hickory—see *Carya*
 Hieracium venosum
 Macrosiphum rudbeckiae (Fitch)
 High-bush cranberry—see *Viburnum opulus* var. *americanum*
 Hog peanut—see *Amphicarpa*
 Holcus Sorghum var. *saccharatus*
 Sipha flava (Forbes)
 Holcus Sorghum var. *technicus*
 Sipha flava (Forbes)
 Honewort—see *Cryptotaenia*
 Honeysuckle—see *Diervilla* and *Lonicera*
 Hop—see *Humulus*
 Hop clover—see *Trifolium procumbens*
 Hornbeam—see *Carpinus*
 Horse chestnut—see *Aesculus*
 Horse mint—see *Monarda*
 Horse radish—see *Radicula Armoracia*
 Horsetweed—see *Erigeron canadensis* and *Lactuca canadensis*
 Humulus Lupulus
 Phorodon humuli (Schränk)
 Hydrangea sp.
 Aphis rumicis L.
 Aphis spiraeicola Patch
 Hypericum sp.
 Hyalopterus hyperici (Monell)
 Impatiens biflora
 Aphis cephalanthi Thomas

- Impatiens* sp.
 Aphis cephalanthi Thomas
 Macrosiphum impatiensicolens Patch
 Macrosiphum pseudorosae Patch
 Indian bean—see *Catalpa*
 Indian hemp—see *Apocynum*
Inula royaleana
 Capitophorus pakansus H. & F.
Ipomoea batatas
 Macrosiphum gei (Koch)
Ipomoea maxima
 Myzus circumflexus (Buckton)
 Myzus persicae (Sulz.)
Iris sp.
 Macrosiphum gei (Koch)
 Iron oak—see *Quercus stellata*
 Ironweed—see *Vernonia*
 Ivy, boston—see *Parthenocissus tricuspidata*

 Japanese barberry—see *Berberis*
 Jewelweed—see *Impatiens*
 Joe Pye weed—see *Eupatorium purpureum* var. *maculatum*
Juglans nigra
 Monellia caryae (Monell)
 Monellia caryella (Fitch)
 Monellia costalis (Fitch)
 Monellia nigropunctata Granovsky
 Juneberry—see *Amelanchier*
 June grass—see *Poa pratensis*
 Juniper—see *Juniperus*
Juniperus virginiana
 Cinara difficilis H. & F.

 Kentucky blue grass—see *Poa pratensis*
 Knotweed—see *Polygonum*

Lactuca canadensis
 Macrosiphum sonchella (Monell)
Lactuca sp.
 Amphorophora cosmopolitana Mason
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum gei (Koch)
 Macrosiphum gravicornis Patch
 Macrosiphum rudbeckiae (Fitch)
 Macrosiphum sonchellum (Monell)
 Myzus lactucae (Schränk)
 Prociphilus erigeronensis (Thomas)
 Lady fern—see *Asplenium Filix-femina*
Lagenaria vulgaris
 Aphis gossypii Glover
 Macrosiphum gei (Koch)
 Lamb's quarters—see *Chenopodium album*
 Larch—see *Larix*
 Large-toothed aspen—see *Populus grandidentata*

Larix laricina
 Cinara laricis (Hartig)
 Larkspur—see *Delphinium*
Lathyrus sp.
 Macrosiphum gei (Koch)
 Macrosiphum pisi (Kalt.)
 Trifidaphis phaseoli (Pass.)
 Laurel oak—see *Quercus imbricaria*
 Laurestinus—see *Viburnum*
 Leafcup—see *Polymnia*
Lemna trisulca
 Rhopalosiphum nymphaeae (L.)
Lepidium virginicum
 Pemphigus populi-transversus Riley
 Rhopalosiphum pseudobrassicae (Davis)
 Lettuce—see *Lactuca*
Liatris elegans
 Aphis zilora H. & F.
Liatris squarrosa
 Aphis funesta H. & F.
 Aphis spiraeicola Patch
Ligustrum vulgare
 Aphis rumicis L.
 Macrosiphum gei (Koch)
 Myzus persicae (Sulz.)
Ligustrum sp.
 Macrosiphum gei (Koch)
Lilium sp.
 Myzus circumflexus (Buckton)
 Lily—see *Lilium*
 Linden—see *Tilia*
Liriodendron Tulipifera
 Macrosiphum liriodendri (Monell)
 Locust—see *Robinia*
 Lombardy poplar—see *Populus nigra* var. *italica*
 Long-leaved pine—see *Pinus palustris*
Lonicera flava
 Rhopalosiphum melliferum (Hottes)
Lonicera sempervirens
 Rhopalosiphum melliferum (Hottes)
Lonicera sp.
 Alphitoaphis lonicericola (Williams)
 Gypsoaphis oestlundii Hottes
 Rhopalosiphum melliferum (Hottes)
 Loosestrife—see *Lysimachia*
 Lotus—see *Nymphaeae*
 Low birch—see *Betula pumila*
 Lucerne—see *Medicago*
Lycopersicon esculentum Mill.
 Amphorophora solani (Thomas)
 Macrosiphum gei (Koch)
 Myzus persicae (Sulz.)
Lysimachia producta
 Thecabius ? sp.

- Mallow—see *Hibiscus* and *Malva*
Malva sp.
 Aphis gossypii Glover
 Maple—see *Acer*
 Marigold—see *Calendula*
Marsilea quadrifolia
 Myzus persicae (Sulz.)
 May weed—see *Anthemis cotula*
 Mazzard—see *Prunus avium*
 Meadow grass—see *Poa*
 Meadow rue—see *Thalictrum*
 Meadow-sweet—see *Spiraea*
Medicago sativa
 Macrosiphum pisi (Kalt.)
 Medick—see *Medicago*
Melilotus alba
 Hysteroneura setariae (Thomas)
 Macrosiphum pisi (Kalt.)
Melilotus officinalis
 Macrosiphum pisi (Kalt.)
 Milfoil—see *Achillea Millefolium*
 Milkweed—see *Asclepias*
Mimulus sp.
 Myzus persicae
 Missouri currant—see *Ribes odoratum*
 Mock orange—see *Philadelphus coronarius*
Monarda fistulosa
 Aphis monardae Oestl.
 Myzus monardae (Williams)
Monarda sp.
 Myzus monardae (Williams)
 Monkey flower—see *Mimulus*
 Morning glory—see *Ipomoea*
 Mossy-cup oak—see *Quercus macrocarpa*
 Mountain ash—see *Pyrus americana*
 Muskmelon—see *Cucumis melo*
 Mustard—see *Brassica*
Myosotis sp.
 Aphis padi L.
 Myzus persicae (Sulz.)

Nasturtium—see *Tropaeolum majus*
 Necklace poplar—see *Populus deltoides*
Nepeta Cataria
 Aphis ageratoides Oestl.
 Aphis rhamni Fonsc.
 Aphis rumicis L.
Nephrolepis sp.
 Idiopterus nephrolepidis Davis
 Nettle—see *Urtica*
 Nightshade—see *Solanum*
 Nine-bark—see *Physocarpus*
 Norway spruce—see *Picea abies*
Nymphaea castaleiflora (?)
 Rhopalosiphum nymphaeae (L.)
Nymphaea sp.
 Aphis maidis Fitch
Nyssa sylvatica
 Aphis coreopsidis (Thomas)
- Oak—see *Quercus*
 Oats—see *Avena*
Oenothera biennis
 Anoecia oenotherae Wilson
 Anoecia setariae G. & P.
 Aphis oestlundii Gillette
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum pseudorosae Patch
Oenothera sp.
 Anoecia oenotherae Wilson
 Anoecia setariae G. & P.
 Aphis oestlundii Gillette
 Ohio buckeye—see *Aesculus glabra*
 Orpine—see *Sedum*
 Osier—see *Salix*
 Over-cup oak—see *Quercus macrocarpa*
 Ox-eye daisy—see *Chrysanthemum*
Oxybaphus nyctagineus
 Aphis rumicis L.

 Panic grass—see *Panicum*
Panicum sp.
 Prociphilus erigeronensis (Thomas)
 Pansy—see *Viola tricolor*
 Paper birch—see *Betula alba* var. *papyrifera*
 Parsnip—see *Pastinaca*
Parthenocissus tricuspidata
 Aphis folsomii Davis
Parthenocissus sp.
 Aphis folsomii Davis
Pastinaca sativa
 Aphis decepta H. & F.
 Aphis rumicis L.
 Aphis spiraeicola Patch
 Macrosiphum gei (Koch)
 Rhopalosiphum melliferum (Hottes)
 Pea—see *Lathyrus* and *Pisum*
 Peach—see *Prunus persica*
 Peach-leaved willow—see *Salix amygdaloides*
 Pear—see *Pyrus communis*
 Pecan—see *Carya illinoensis*
Pentstemon sp.
 Macrosiphum gei (Koch)
 Pepper—see *Capsicum*
 Peppergrass—see *Lepidium*
 Pepperidge—see *Nyssa*
 Pepperwort—see *Lepidium*
Philadelphus coronarius
 Aphis rumicis L.
 Myzus persicae (Sulz.)
Phragmites sp.
 Hyalopterus pruni (Geoffroy)
Physocarpus opulifolius
 Aphis neilliae Oestl.
Picea Abies
 Cinara pinicola (Kalt.)
Picea canadensis
 Cinara pinicola (Kalt.)

- Picea* sp.
 Cinara palmerae (Gill.)
 Cinara pinicola (Kalt.)
 Pigeon grass—see *Setaria glauca*
 Pigeon plum—see *Coccoloba laurifolia*
 Pigweed—see *Amaranthus retroflexus* and *Chenopodium album*
Pilea pumila
 Asiphonaphis anogis H. & F.
 Pine—see *Pinus*
 Pink—see *Dianthus*
 Pin oak—see *Quercus palustris*
Pinus echinata
 Eulachnus rileyi (Williams)
Pinus palustris
 Eulachnus rileyi (Williams)
Pinus Strobus
 Cinara strobis (Fitch)
 Eulachnus rileyi (Williams)
 Mindarus abietinus Koch
Pinus sylvestris
 Cinara pini (L.)
 Eulachnus rileyi (Williams)
Piqueria trinervia
 Myzus persicae (Sulz.)
Pisum sativum
 Macrosiphum gei (Koch)
 Macrosiphum pisi (Kalt.)
Plantago sp.
 Aphis maidi-radici Forbes
 Aphis roseus Baker
 Myzus persicae (Sulz.)
 Myzus plantagineus Pass.
 Plaintain—see *Plantago*
Platanus occidentalis
 Longistigma caryae (Harris)
 Plum—see *Prunus domestica*
 Plumed thistle—see *Cirsium*
Poa pratensis
 Capitophorus poae (Gill.)
Poa sp.
 Amphorophora nebulosa H. & F.
 Forda occidentalis Hart
 Geoica squamosa Hart
 Prociphilus erigeronensis (Thomas)
 Rhopalosiphum prunifoliae (Fitch)
Polygonatum sp.
 Macrosiphum gei (Koch)
 Macrosiphum kickapoo H. & F.
Polygonum hydropiper
 Aphis maidi-radici Forbes
 Aphis spiraeola Patch
 Capitophorus gillettei Theobald
Polygonum Muhlenbergii
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum gei (Koch)
 Macrosiphum pisi (Kalt.)
Polygonum sp.
 Macrosiphum gei (Koch)
Polymnia canadensis
 Macrosiphum zinzalae H. & F.
Polymnia sp.
 Capitophorus gillettei Theobald
 Macrosiphum gei (Koch)
 Pondweed—see *Potamogeton*
 Poor robin's plantain—see *Hieracium venosum*
Poplar—see *Populus*
Populus deltoides
 Asiphum pseudobyrza Walsh
 Chaitophorus populifoliae Oestl.
 Chaitophorus neglectus H. & F.
 Clavigerus smithiae (Monell)
 Mordwilkoja vagabunda (Walsh)
 Pemphigus nortoni Maxson
 Pemphigus populicaulis Fitch
 Pemphigus populi-transversus Riley.
 Pemphigus populi-venae Fitch
 Periphyllus populicola (Thomas)
 Prociphilus venafuscus (Patch)
Populus grandidentata
 Chaitophorus neglectus H. & F.
 Chaitophorus populifoliae Oestl.
 Clavigerus smithiae (Monell)
Populus heterophylla
 Chaitophorus populifoliae Oestl.
Populus nigra var. *italica*
 Periphyllus populicola (Thomas)
Populus tremuloides
 Aphis maculatae Oestl.
 Chaitophorus populifoliae Oestl.
 Periphyllus populicola (Thomas)
Populus sp.
 Asiphum pseudobyrza Walsh
 Pemphigus populi-transversus Riley
 Periphyllus populicola (Thomas)
Portulaca oleracea
 Aphis gossypii Glover
 Myzus persicae (Sulz.)
Portulaca sp.
 Aphis maidi-radici Forbes
 Post oak—see *Quercus stellata*
Potamogeton natans
 Rhopalosiphum nymphaeae (L.)
Potamogeton sp.
 Rhopalosiphum nymphaeae (L.)
 Potato—see *Solanum tuberosum*
Potentilla monspeliensis
 Capitophorus fragaefolii (Ckll.)
Potentilla sp.
 Capitophorus fragaefolii (Ckll.)
 Macrosiphum pseudorosae Patch
Prenanthes alba
 Amphorophora nabali (Oestl.)
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum chrysanthemi (Oestl.)
Prenanthes sp.
 Macrosiphum ambrosiae (Thomas)
 Prim—see *Ligustrum*
 Primrose—see *Oenothera* and *Streptocarpus*

- Privet—see *Ligustrum*
 Prune—see *Prunus domestica*
Prunus americana
 Myzus persicae (Sulz.)
Prunus avium
 Hysteroneura setariae (Thomas)
 Myzus cerasi (Fabr.)
 Myzus persicae (Sulz.)
Prunus domestica
 Aphis pomi DeGeer
 Hyalopterus pruni (Geoffroy)
 Hysteroneura setariae (Thomas)
 Myzus persicae (Sulz.)
Prunus japonica
 Aphis pomi DeGeer
 Rhopalosiphum prunifoliae (Fitch)
Prunus nigra
 Aphis cerasifoliae Fitch
 Hysteroneura setariae (Thomas)
Prunus Persica
 Aphis padi L.
 Aphis persicae-niger Smith
 Hysteroneura setariae (Thomas)
 Myzus cerasi (F.)
 Myzus persicae (Sulz.)
Prunus serotina
 Aphis feminea Hottes
 Myzus persicae (Sulz.)
Prunus triloba
 Hysteroneura setariae (Thomas)
Prunus virginiana
 Aphis cerasifoliae Fitch
 Aphis pomi DeGeer
 Asiphonaphis pruni Wilson & Davis
 Hysteroneura setariae (Thomas)
Prunus sp.
 Aphis cerasifoliae Fitch
 Aphis chetansapa H. & F.
 Asiphonaphis pruni Wilson & Davis
 Hysteroneura setariae (Thomas)
 Pumpkin—see *Cucurbita Pepo*
 Purple amaranth—see *Amaranthus paniculatus*
 Purslane—see *Portulaca*
Pyrus americana
 Aphis pomi DeGeer
Pyrus arbutifolia var. *atropurpurea*
 Aphis cerasifoliae Fitch
Pyrus communis
 Aphis pomi DeGeer
Pyrus Malus
 Aphis maidis Fitch
 Aphis pomi DeGeer
 Aphis roseus Baker
 Eriosoma lanigera (Hausmann)
 Rhopalosiphum prunifoliae (Fitch)
Pyrus sp.
 Aphis chetansapa H. & F.
 Aphis pomi DeGeer
 Quaking asp—see *Populus tremuloides*
 Quercitron oak—see *Quercus velutina*
Quercus alba
 Drepanaphis acerifoliae (Thomas)
 Myzocallis alhambra Davidson
 Myzocallis discolor (Monell)
 Myzocallis walshii (Monell)
 Stegophylla quercicola (Baker)
 Tuberculatus punctatellus (Fitch)
Quercus bicolor
 Myzocallis alhambra Davidson
 Myzocallis walshii (Monell)
Quercus imbricaria
 Myzocallis walshii (Monell)
Quercus macrocarpa
 Chaitophorus quercicola (Monell)
 Myzocallis alhambra Davidson
 Myzocallis discolor (Monell)
 Neosymydobius albasiphus (Davis)
 Stegophylla quercicola (Baker)
 Tuberculatus punctatellus (Fitch)
Quercus marilandica
 Myzocallis punctata (Monell)
Quercus palustris
 Myzocallis discolor (Monell)
 Myzocallis punctata (Monell)
 Myzocallis walshii (Monell)
Quercus stellata
 Neosymydobius albasiphus (Davis)
 Neosymydobius memorialis H. & F.
 Stegophylla quercicola (Baker)
Quercus velutina
 Myzocallis bella (Walsh)
 Myzocallis walshii (Monell)
 Tuberculatus punctatellus (Fitch)
Quercus sp.
 Anoecia querci (Fitch)
 Monellia caryella (Fitch)
 Myzocallis alhambra Davidson
 Myzocallis bella (Walsh)
 Myzocallis discolor (Monell)
 Myzocallis punctata (Monell)
 Myzocallis walshii (Monell)
 Neosymydobius albasiphus (Davis)
 Tuberculatus punctatellus (Fitch)
 Quince—see *Prunus japonica*
 Radicula *Armoracia*
 Myzus persicae (Sulz.)
 Radish—see *Raphanus sativus*
 Ragweed—see *Ambrosia*
 Ragwort—see *Senecio*
Ranunculus sp.
 Thecabius gravicornus Patch
Raphanus sativus
 Myzocallis asclepiadis (Monell)
 Myzus persicae (Sulz.)
 Rhopalosiphum pseudobrassicae (Davis)
 Raspberry—see *Rubus occidentalis*

- Rattlesnake-root—see *Prenanthes*
 Rattlesnake-weed—see *Hieracium venosum*
 Red birch—see *Betula nigra*
 Red cedar—see *Juniperus virginiana*
 Red clover—see *Trifolium pratense*
 Red elm—see *Ulmus fulva*
 Red-osier dogwood—see *Cornus stolonifera*
 Reed—see *Phragmites*
 Rhamnus lanceolata
 Aphis rhamni Fonsc.
Rhus canadensis
 Rhopalosiphum rhois (Monell)
Rhus glabra
 Rhopalosiphum rhois (Monell)
Rhus sp.
 Liosomaphis rhois (Monell)
 Melaphis rhois (Fitch)
Ribes Grossularia
 Aphis sanborni Patch
 Capitophorus ribis (L.)
 Myzus houghtonensis (Troop)
Ribes nigrum
 Amphorophora cosmopolitana Mason
 Aphis sanborni Patch
 Capitophorus ribis (L.)
Ribes odoratum
 Amphorophora cosmopolitana Mason
 Capitophorus ribis (L.)
 Macrosiphum ribiellum Davis
 Myzus persicae (Sulz.)
Ribes sp.
 Aphis sanborni Patch
 Capitophorus ribis (L.)
 Macrosiphum ribiellum Davis
 Myzus houghtonensis (Troop)
 Myzus thomasi H. & F.
Ribwort—see *Plantago*
Richweed—see *Pilea*
River birch—see *Betula nigra*
Robinia Pseudo-Acacia
 Aphis laburni Kalt.
 Aphis rumicis L.
Rock cress—see *Arabis*
Rock moss—see *Sedum*
Rosa rugosa
 Capitophorus fragaefolii (Ckll.)
 Myzus porosus (Sanderson)
Rosa sp.
 Capitophorus corambus H. & F.
 Capitophorus fragaefolii (Ckll.)
 Capitophorus tetrarhodus (Walker)
 Macrosiphum dirhodum (Walker)
 Macrosiphum gei (Koch)
 Macrosiphum pseudorosae Patch
 Macrosiphum rosae (L.)
 Myzus circumflexus (Buckton)
 Myzus porosus Sanderson
Rose—see *Rosa*
Rose mallow—see *Hibiscus*
Rosin-weed—see *Silphium*
Rubus sp.
 Amphorophora sensoria Mason
 Aphis rubicola Oestl.
 Cerosipha rubifolii (Thomas)
Rudbeckia hirta
 Macrosiphum ambrosiae (Thomas)
Rudbeckia laciniata var. *hortensia*
 Macrosiphum rudbeckiae (Fitch)
Rudbeckia sp.
 Macrosiphum rudbeckiae (Fitch)
Rum cherry—see *Prunus serotina*
Rumex crispus
 Aphis rumicis L.
 Aphis spiraeicola Patch
 Macrosiphum venaefuscae Davis
Rumex sp.
 Aphis rumicis L.
 Macrosiphum gei (Koch)
Russian olive—see *Elaeagnus*
Saccharum officinarum
 Sipha flava (Forbes)
St. John's wort—see *Hypericum*
Salix amygdaloides
 Chaitophorus pusillus H. & F.
Salix longifolia
 Cavariella aegopodii (Scopoli)
 Chaitophorus viminalis Monell
Salix nigra
 Aphis saliceti Kaltenbach
 Chaitophorus viminalis Monell
 Clavigerus smithiae (Monell)
Salix sp.
 Aphis saliceti Kaltenbach
 Cavariella aegopodii (Scopoli)
 Chaitophorus viminalis Monell
 Clavigerus populifoliae (Fitch)
 Clavigerus smithiae (Monell)
 Macrosiphum laevigatae Essig
 Myzus porosus Sanderson
 Plocamaphis flocculosa (Weed)
 Plocamaphis terriicola H. & F.
 Tuberolachnus saligna (Gmel.)
Salvia leucantha
 Myzus persicae (Sulz.)
Sambucus canadensis
 Aphis sambucifoliae Fitch
 Myzus persicae (Sulz.)
Sambucus sp.
 Aphis pomi DeGeer
 Aphis sambucifoliae Fitch
Sand bar willow—see *Salix longifolia*
Sanguinaria canadensis
 Macrosiphum sanguinarium H. & F.
Sanicle—see *Sanicula*
Sanicula sp.
 Aphis signatis H. & F.
Saxifraga splendens
 Aphis gossypii Glover
 Macrosiphum gei (Koch)
 Myzus persicae (Sulz.)
Saxifrage—see *Saxifraga*

- Scrophularia leporella*
Macrosiphum gei (Koch)
Scrophularia nodosa
Myzus scrophulariae (Thomas)
 Scorpion-grass—see *Myosotis*
 Scotch fir—see *Pinus sylvestris*
 Scotch pine—see *Pinus sylvestris*
 Scrub oak—see *Quercus marilandica*
 Seaside grape—see *Coccoloba*
 Sedge—see *Carex*
Sedum artissimum
Myzus persicae (Sulz.)
Sedum reflexum
Aphis gossypii Glover
Senecio cruentus
Aphis padi L.
Senecio glabellus
Aphis nyctalis H. & F.
Senecio vulgaris
Macrosiphum gei (Koch)
Setaria glauca
Geocia squamosa Hart
Hysteroneura setariae (Thomas)
Setaria viridis
Hysteroneura setariae (Thomas)
Myzus persicae (Sulz.)
Setaria sp.
Anoecia querci (Fitch)
Pemphigus populi-transversus Riley
 Shag-bark hickory—see *Carya ovata*
 Sheepberry—see *Viburnum lentago*
 Shell-bark hickory—see *Carya ovata*
 Shepherd's purse—see *Capsella Bursa-pastoris*
 Shield fern—see *Aspidium*
 Shingle oak—see *Quercus imbricaria*
 Shooting star—see *Dodecatheon*
Meadia
 Shrubby bitter-sweet—see *Celastrus*
Silphium integrifolium
Macrosiphum pallens H. & F.
Silphium perfoliatum
Macrosiphum rudbeckiae (Fitch)
 Silver maple—see *Acer saccharinum*
 Sky-flower—see *Senecio*
 Slippery elm—see *Ulmus fulva*
 Smartweed—see *Polygonum*
Smilax rotundifolia
Neoprociphilus aceris (Monell)
Neoprociphilus attenuatus (O. & S.)
 Smooth sumach—see *Rhus glabra*
 Snakeroot—see *Eupatorium urticaefolium*, *Liatris*, and *Sanicula*
 Sneezeweed—see *Helenium*
 Snowberry—see *Symphoricarpos*
 Snow-on-the-mountain—see *Euphorbia marginata*
 Soft maple—see *Acer saccharinum*
Solanum dulcamara L.
Macrosiphum pisi (Kalt.)
Solanum melongena
Macrosiphum gei (Koch)
Myzus persicae (Sulz.)
Solanum tuberosum
Macrosiphum gei (Koch)
Myzus persicae (Sulz.)
Solanum sp.
Aphis rumicis L.
Solidago canadensis
Aphis solidaginifoliae Williams
Macrosiphum erigeronensis (Thomas)
Macrosiphum gravicornis Patch
Macrosiphum rudbeckiae (Fitch)
Solidago nemoralis
Macrosiphum rudbeckiae (Fitch)
Solidago sp.
Aphis solidaginifoliae Williams
Macrosiphum ambrosiae (Thomas)
Macrosiphum chrysanthemi (Oestl.)
Macrosiphum erigeronensis (Thomas)
Macrosiphum gravicornis Patch
Macrosiphum rudbeckiae (Fitch)
Pemphigus brevicornis (Hart)
 Solomon's seal—see *Polygonatum*
Sonchus arvensis
Amphorophora cosmopolitana Mason
Sonchus oleraceus
Amphorophora cosmopolitana Mason
Sonchus sp.
Aphis rumicis L.
Amphorophora cosmopolitana Mason
Capitophorus flaveolus (Walker)
Macrosiphum ambrosiae (Thomas)
 Sorghum—see *Holcus Sorghum* var. *saccharatus*
 Sorrel—see *Rumex*
 Sour gum—see *Nyssa*
 Southernwood—see *Artemisia abrotanum*
 Sow thistle—see *Sonchus arvensis*
 Spanish bayonet—see *Yucca*
 Spatter-dock—see *Nymphaea*
 Spear grass—see *Poa*
 Spinach—see *Spinacia oleracea*
Spinacia oleracea
Aphis gossypii Glover
Macrosiphum gei (Koch)
Myzus persicae (Sulz.)
 Spindle tree—see *Evonymus*
Spiraea latifolia
Aphis spiraeicola Patch
Aphis spiraeophila Patch
Spiraea salicifolia
Aphis spiraeophila Patch
Spiraea Vanhouttei
Aphis spiraeicola Patch
Spiraea sp.
Aphis spiraeicola Patch

- Spleenwort—see *Asplenium*
 Spotted touch-me-not—see *Impatiens biflora*
 Spruce—see *Picea*
 Spurge—see *Euphorbia*
 Spurgewort—see *Salvia*
 Squash—see *Cucurbita maxima*
 Squaw-weed—see *Senecio*
 Staff tree—see *Celastrus*
 Stick-tight—see *Bidens vulgata*
 Stiff cornel—see *Cornus stricta*
 Stonecrop—see *Sedum*
 Strawberry—see *Fragaria*
 Strawflower—*Helichrysum*
 Streptocarpus sp.
 Myzus circumflexus (Buckton)
 Sugar cane—see *Saccharum officinarum*
 Sugar maple—see *Acer saccharum*
 Sumach—see *Rhus*
 Sunflower—see *Helianthus*
 Swamp birch—see *Betula pumila*
 Swamp milkweed—see *Asclepias incarnata*
 Swamp spanish oak—see *Quercus palustris*
 Swamp white oak—see *Quercus bicolor*
 Sweet cherry—see *Prunus avium*
 Sweet clover—see *Melilotus*
 Sweet pea—see *Lathyrus*
 Sweet pepper—see *Capsicum dulce*
 Sweet potato—see *Ipomoea batatas*
 Sweet viburnum—see *Viburnum Lentago*
 Sword fern—see *Nephrolepis*
 Sycamore—see *Platanus occidentalis*
 Symphoricarpos orbiculatus
 Amphiceridius pulverulens (Gill.)
 Syringa—see *Philadelphus coronarius*

 Tamarack—see *Larix laricina*
 Taraxacum officinale
 Aphis knowltoni H. & F.
 Macrosiphum ambrosiae (Thomas)
 Macrosiphum taraxaci (Kalt.)
 Prociphilus erigeronensis (Thomas)
 Tare—see *Vicia*
 Thalictrum sp.
 Macrosiphum purpurascens (Oestl.)
 Thistle—see *Cirsium*, *Piqueria*, and *Sonchus*
 Thoroughwort—see *Eupatorium*
 Tick trefoil—see *Desmodium*
 Tilia americana
 Hysteroneura setariae (Thomas)
 Longistigma caryae (Harris)
 Macrosiphum tiliae (Monell)
 Myzocallis tiliae (L.)
 Tomato—see *Lycopersicon esculentum*

 Touch-me-not—see *Impatiens*
 Trachelospermum difforme
 Macrosiphum gei (Koch)
 Trefoil—see *Trifolium*
 Trifolium pratense
 Aphis bakeri Cowen
 Aphis cerasifoliae Fitch
 Aphis crataegifoliae Fitch
 Macrosiphum granarium (Kby.)
 Macrosiphum pisi (Kalt.)
 Myzocallis ononidis (Kalt.)
 Sipha flava (Forbes)
 Trifolium procumbens
 Macrosiphum pisi (Kalt.)
 Myzocallis ononidis (Kalt.)
 Trifolium repens
 Macrosiphum gei (Koch)
 Macrosiphum pisi (Kalt.)
 Trifolium sp.
 Geocica squamosa Hart
 Macrosiphum pisi (Kalt.)
 Myzocallis ononidis (Kalt.)
 Triticum aestivum
 Macrosiphum granarium (Kby.)
 Triticum sp.
 Macrosiphum granarium (Kby.)
 Myzocallis discolor (Monell)
 Rhopalosiphum prunifoliae (Fitch)
 Sipha flava (Forbes)
 Toxoptera graminum (Rond.)
 Tropaeolum majus
 Aphis rumicis L.
 Trumpet weed—see *Eupatorium purpureum*
 Trumpet honeysuckle—see *Lonicera sempervirens*
 Tulip—see *Tulipa*
 Tulip tree—see *Liriodendron*
 Tulipa sp.
 Aphis rumicis L.
 Tupelo—see *Nyssa*
 Turnip—see *Brassica rapa*
 Typha latifolia
 Rhopalosiphum enigmae H. & F.

 Ulmus alata
 Georgiaphis ulmi (Wilson)
 Tuberculatus ulmifolii (Monell)
 Ulmus americana
 Colopha ulmicola (Fitch)
 Eriosoma lanigera (Hausmann)
 Tuberculatus ulmifolii (Monell)
 Ulmus fulva
 Colopha graminis (Monell)
 Colopha ulmicola (Fitch)
 Eriosoma crataegi (Oestl.)
 Eriosoma mimica H. & F.
 Eriosoma rileyi (Thomas)
 Georgiaphis ulmi (Wilson)
 Gobaishia ulmi-fusus (Walsh)
 Macrosiphum gei (Koch)
 Tuberculatus ulmifolii (Monell)

- Ulmus* sp.
Colopha graminis Monell
Colopha ulmicola (Fitch)
Eriosoma lanigera (Hausmann)
Gobaishia ulmi-fusus (Walsh)
Tuberculatus ulmifolii (Monell)
Urtica sp.
Aphis rumicis L.
Vaccinium vacillans
Amphorophora vaccinii Mason
Verbena sp.
Myzus persicae (Sulz.)
Vernonia fasciculata
Aphis vernoniae Thomas
Vernonia sp.
Aphis spiraeicola Patch
Vervain—see *Verbena*
Vetch—see *Vicia*
Vetchling—see *Lathyrus*
Viburnum Lentago
Aphis viburnicola Gill.
Viburnum Opulus var. *americanum*
Aphis rumicis L.
Aphis viburnicola Gill.
Aphis viburniphila Patch
Viburnum sp.
Aphis bakeri Cowen
Aphis crataegifoliae Fitch
Aphis rumicis L.
Aphis spiraeicola Patch
Aphis viburnicola Gill.
Aphis viburniphila Patch
Vicia sp.
Macrosiphum pisi (Kalt.)
Viola tricolor
Myzus persicae (Sulz.)
Viola sp.
Idiopterus violae (Pergande)
Violet—see *Viola*
Virginia creeper—see *Parthenocissus*
Vitis labrusca
Aphis illinoisensis Shimer
Vitis sp.
Aphis illinoisensis Shimer
Aphis spiraeicola Patch

Wahoo—see *Evonymus atropurpureus*
Wahoo—see *Ulmus alata*
Walnut—see *Juglans nigra*
Water beech—see *Carpinus caroliniana*
Water cress—see *Radicula*
Water hyacinth—see *Eichhornia*
Water lily—see *Castalia* and *Nymphaea*
Water pepper—see *Polygonum hydropiper*
Water shield—see *Brasenia*
Waxwork—see *Celastrus scandens*
Weeping birch—see *Betula pendula*
Wheat—see *Triticum*

White Birch—see *Betula pendula* and *Betula alba* var. *papyrifera*
White clover—see *Trifolium repens*
White elm—see *Ulmus americana*
White lettuce—see *Prenanthes alba*
White melilot—see *Melilotus alba*
White oak—see *Quercus alba*
White Pine—see *Pinus Strobus*
White snake-root—see *Eupatorium urticaefolium*
White spruce—see *Picea canadensis*
White thorn—see *Crataegus*
White water lily—see *Castalia*
Whitewood tree—see *Liriodendron tulipifera*
Wild bergamot—see *Monarda fistulosa*
Wild black cherry—see *Prunus serotina*
Wild cranesbill—see *Geranium maculatum*
Wild lettuce—see *Lactuca canadensis*
Wild plum—see *Prunus nigra* and *Prunus americana*
Wild rye—see *Elymus*
Willow—see *Salix*
Winged elm—see *Ulmus alata*
Winged pigweed—see *Cycloloma*
Witch hazel—see *Hamamelis*
Woodbine—see *Parthenocissus*
Wood fern—see *Aspidium*
Wood mint—see *Blephilia hirsuta*
Wormwood—see *Artemisia*

Xanthium canadense
Macrosiphum ambrosiae (Thomas)

Yard grass—see *Eleusine*
Yarrow—see *Achillea*
Yellow barked oak—see *Quercus velutina*
Yellow daisy—see *Rudbeckia hirta*
Yellow dock—see *Rumex crispus*
Yellow honeysuckle—see *Lonicera flava*
Yellow melilot—see *Melilotus officinalis*
Yellow pine—see *Pinus echinata* and *Pinus palustris*
Yellow pond lily—see *Nymphaea*
Yellow poplar—see *Liriodendron tulipifera*
Yucca sp.
Aphis rumicis L.

Zea Mays
Anoecia querci (Fitch)
Aphis maidi-radicis Forbes
Aphis maidis Fitch
Colopha graminis (Monell)
Geocia squamosa Hart
Macrosiphum granarium (Kby.)
Pemphigus brevicornis (Hart)
Sipha flava (Forbes)

Zizia aurea

Aphis luridis H. & F.

Aphis signatis H. & F.

Zizia sp.

Aphis luridis H. & F.

Aphis signatis H. & F.

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EXPLANATION OF PLATE I

WINGS

- Fig. 51 *Mindarus abietinus* Koch.
Fig. 52 *Tuberolachnus saligna* (Gmelin).
Fig. 53 *Hormaphis hamamelidis* (Fitch).
Fig. 54 *Periphyllus populicola* (Thomas).
Fig. 55 *Paducia antennatum* (Patch).
Fig. 56 *Tuberculatus punctatellus* (Fitch).
Fig. 57 *Calaphis castaneae* (Fitch).
Fig. 58 *Idiopterus nephrolepidis* Davis.
Fig. 59 *Longistigma caryae* (Harris).
Fig. 60 *Eulachnus rileyi* (Williams).
Fig. 61 *Myzocallis discolor* (Monell).
Fig. 62 *Chaitophorus quercicola* (Monell).
Fig. 63 *Myzocallis bella* (Walsh).
Fig. 64 *Colopha graminis* (Monell).
Fig. 65 *Calaphis betulella* Walsh.
Fig. 66 *Idiopterus nephrolepidis* Davis.
Fig. 67 *Cinara strobis* (Fitch).
Fig. 68 *Anoecia querci* (Fitch).
Fig. 69 *Colopha ulmicola* (Fitch).
Fig. 70 *Chaitophorus pusillus* Hottes and Frison.
Fig. 71 *Myzocallis punctata* (Monell).
Fig. 72 *Euceraphis betulae* (Koch).
Fig. 73 *Melaphis rhois* (Fitch).
Fig. 74 *Pentalonia nigronervosa* Coquerel.

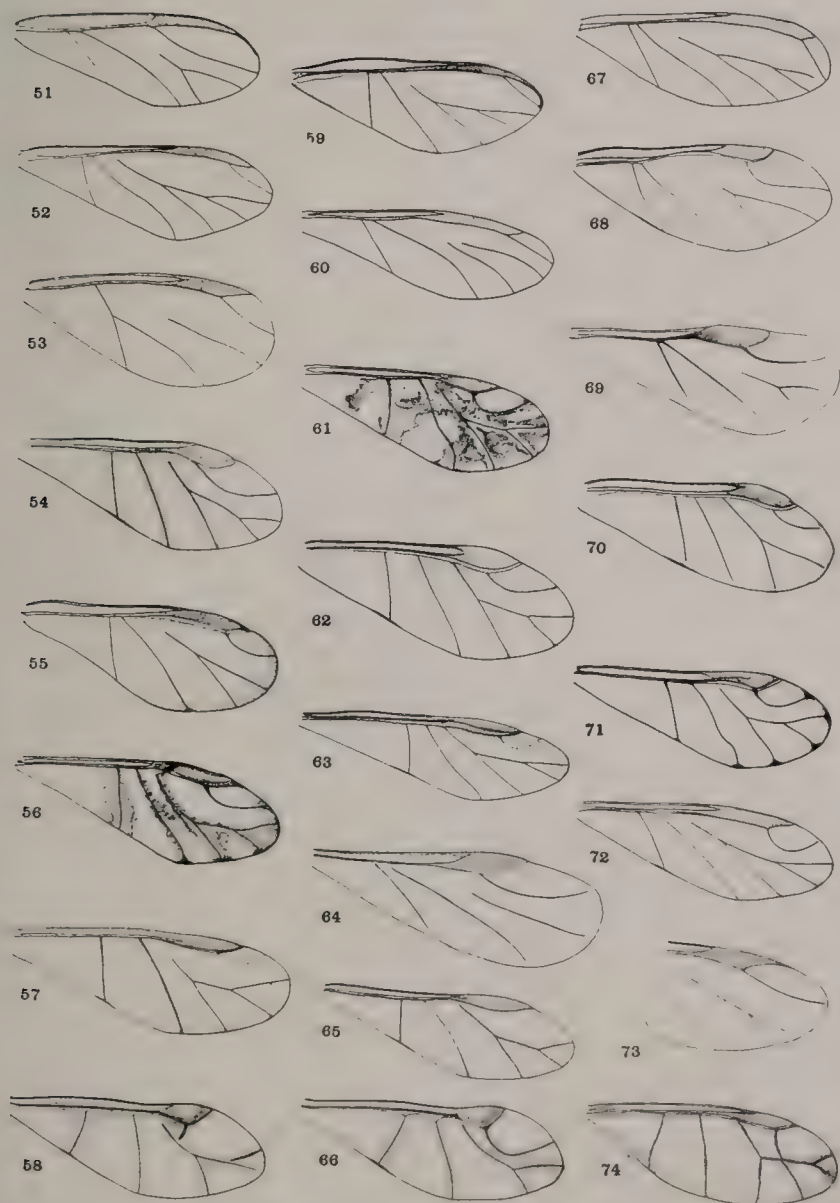


PLATE I

EXPLANATION OF PLATE II

HEADS AND WINGS

- Fig. 75 *Paducia antennatum* (Patch), head, alate, viviparous female.
 Fig. 76 *Paducia antennatum* (Patch), head, alate viviparous female.
 Fig. 77 *Clavigerus populifoliae* (Fitch), head, alate viviparous female.
 Fig. 78 *Calaphis betulella* Walsh, head, alate viviparous female.
 Fig. 79 *Alphitoaphis lonicericola* (Williams), head, alate viviparous female.
 Fig. 80 *Aphis rumicis* Linnaeus, head, alate viviparous female.
 Fig. 81 *Neosymydobius memorialis* Hottes and Frison, head, alate viviparous female.
 Fig. 82 *Capitophorus patonkus* Hottes and Frison, head, alate viviparous female.
 Fig. 83 *Tamalia coweni* (Cockerell), head, alate viviparous female.
 Fig. 84 *Macrosiphum rosae* (Linnaeus), head, alate viviparous female.
 Fig. 85 *Phorodon humuli* (Schrank), head, alate viviparous female.
 Fig. 86 *Myzus monardae* (Davis), head, alate viviparous female.
 Fig. 87 *Gobaishia ulmi-fusus* (Walsh), hind wing.
 Fig. 88 *Colopha graminis* (Monell), hind wing.
 Fig. 89 *Hysteroneura setariae* (Thomas), hind wing.
 Fig. 90 *Aphis crataegifoliae* Fitch, fore wing.
 Fig. 91 *Myzus persicae* (Sulzer), hind wing.
 Fig. 92 *Eriosoma crataegi* (Oestlund), hind wing.
 Fig. 93 *Alphitoaphis lonicericola* (Williams), hind wing.
 Fig. 94 *Pemphigus populi-venae* Fitch, hind wing.
 Fig. 95 *Pentalonia nigronervosa* Coquerel, hind wing.
 Fig. 96 *Microparsus variabilis* Patch, hind wing.
 Fig. 97 *Prociphilus imbricator* (Fitch), portion of fore wing.
 Fig. 98 *Pemphigus populi-transversus* Riley, portion of fore wing.
 Fig. 99 *Aphis bakeri* Cowen, portion of fore wing.

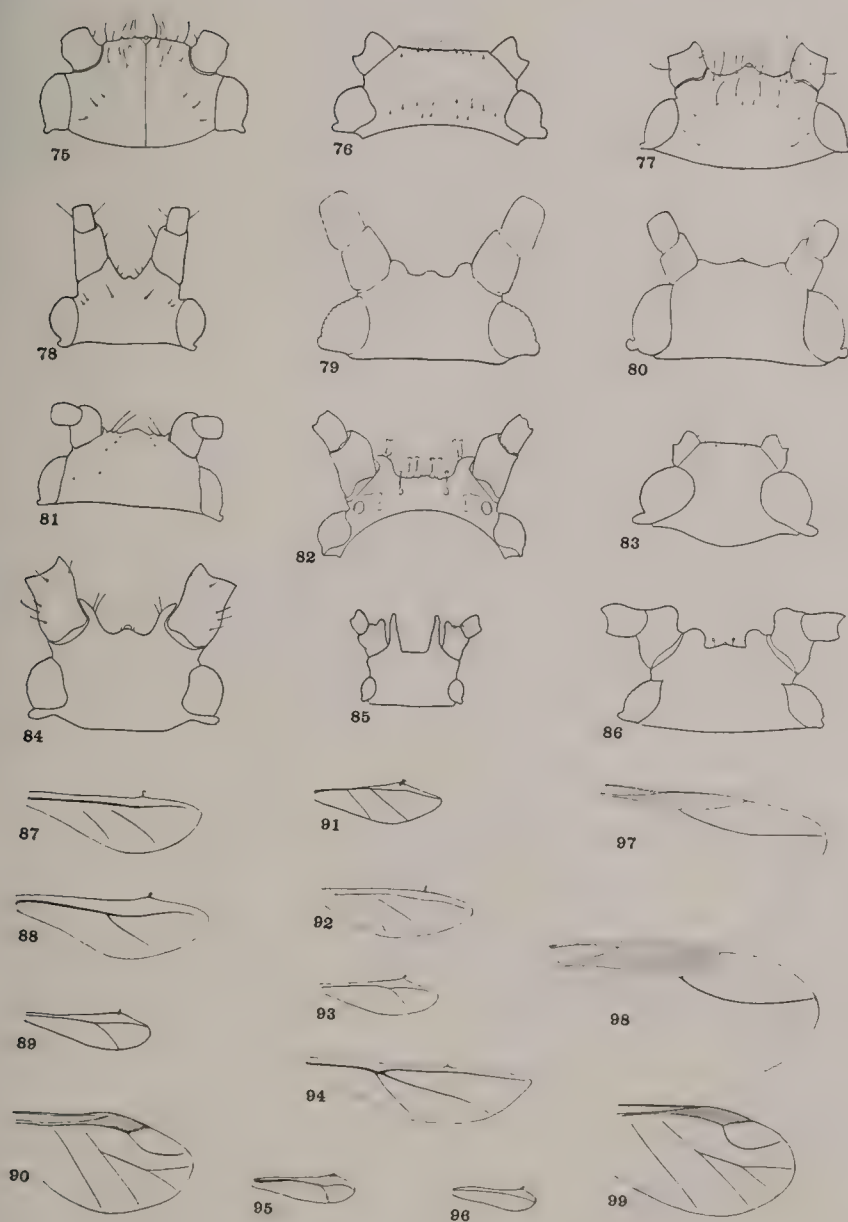


PLATE II

EXPLANATION OF PLATE III

CORNICLES

ALATE VIVIPAROUS FEMALES

EXCEPT FIG. 104, WHICH IS APTEROUS

- Fig. 100 *Macrosiphum frigidicola* (Gillette and Palmer).
Fig. 101 *Macrosiphum adianti* (Oestlund).
Fig. 102 *Macrosiphum carpinicolens* Patch.
Fig. 103 *Macrosiphum illini* Hottes and Frison.
Fig. 104 *Macrosiphum sonchella* (Monell).
Fig. 105 *Macrosiphum sanguinarium* Hottes and Frison.
Fig. 106 *Macrosiphum sanborni* Gillette.
Fig. 107 *Macrosiphum tardae* Hottes and Frison.
Fig. 108 *Macrosiphum rosae* (Linnaeus).
Fig. 109 *Macrosiphum kickapoo* Hottes and Frison.
Fig. 110 *Macrosiphum liriiodendri* (Monell).
Fig. 111 *Macrosiphum gei* (Koch).
Fig. 112 *Macrosiphum pallens* Hottes and Frison.
Fig. 113 *Macrosiphum sonchella* (Monell).
Fig. 114 *Macrosiphum ambrosiae* (Thomas).
Fig. 115 *Macrosiphum ruralis* Hottes and Frison.
Fig. 116 *Macrosiphum anomalae* Hottes and Frison.
Fig. 117 *Macrosiphum tapuskae* Hottes and Frison.
Fig. 118 *Macrosiphum schranki* Theobald.
Fig. 119 *Capitophorus pakansus* Hottes and Frison.
Fig. 120 *Macrosiphum zinzalae* Hottes and Frison.
Fig. 121 *Amphorophora rossi* Hottes and Frison.
Fig. 122 *Amphorophora singularis* Hottes and Frison.
Fig. 123 *Amphorophora nervata* (Gillette).
Fig. 124 *Myzus houghtonensis* (Troop), lectotype.
Fig. 125 *Capitophorus corambus* Hottes and Frison.
Fig. 126 *Amphorophora vaccinii* Mason.
Fig. 127 *Amphorophora nebulosa* Hottes and Frison.
Fig. 128 *Capitophorus patonkus* Hottes and Frison.
Fig. 129 *Myzus porosus* Sanderson.

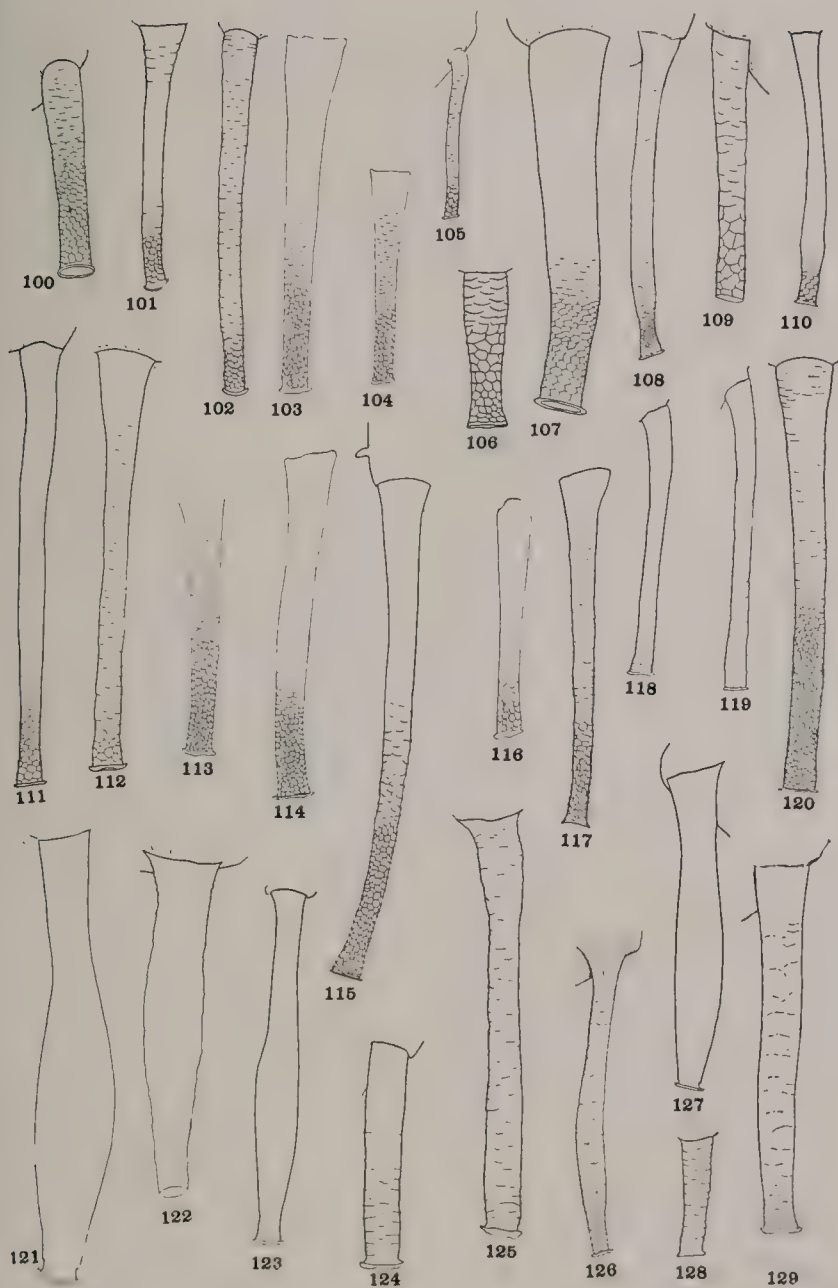


PLATE III

EXPLANATION OF PLATE IV

CORNICLES

ALATE VIVIPAROUS FEMALES

- Fig. 130 *Aphis decepta* Hottes and Frison.
Fig. 131 *Aphis funesta* Hottes and Frison.
Fig. 132 *Aphis carduella* Walsh.
Fig. 133 *Aphis cornifoliae* Fitch.
Fig. 134 *Rhopalosiphum enigmae* Hottes and Frison.
Fig. 135 *Hysteroneura setariae* (Thomas).
Fig. 136 *Alphitoaphis lonicericola* (Williams).
Fig. 137 *Aphis nyctalis* Hottes and Frison.
Fig. 138 *Cerosipha rubifolii* (Thomas).
Fig. 139 *Aphis roseus* Baker.
Fig. 140 *Aphis caliginosa* Hottes and Frison.
Fig. 141 *Aphis pulchella* Hottes and Frison.
Fig. 142 *Aphis chetansapa* Hottes and Frison.
Fig. 143 *Aphis zilora* Hottes and Frison.
Fig. 144 *Amphicercidus pulverulens* (Gillette).
Fig. 145 *Clavigerus smithiae* (Monell).
Fig. 146 *Clavigerus populifoliae* (Fitch).
Fig. 147 *Clavigerus populifoliae* (Fitch).
Fig. 148 *Rhopalosiphum berberidis* (Kaltenbach).
Fig. 149 *Paducia antennatum* (Patch).
Fig. 150 *Neosymydobius memorialis* Hottes and Frison.
Fig. 151 *Chaitophorus pusillus* Hottes and Frison.
Fig. 152 *Periphyllus negundinis* (Thomas).
Fig. 153 *Cinara laricis* (Hartig).
Fig. 154 *Drepanaphis acerifoliae* (Thomas).
Fig. 155 *Monellia costalis* (Fitch).
Fig. 156 *Melanocallis fumipennella* (Fitch).
Fig. 157 *Monellia caryella* (Fitch).
Fig. 158 *Eriosoma lanigera* (Hausmann).
Fig. 159 *Phyllaphis fagi* (Linnaeus).
Fig. 160 *Brevicoryne brassicae* Linnaeus.
Fig. 161 *Plocamaphis terricola* Hottes and Frison.
Fig. 162 *Plocamaphis flocculosum* (Weed).

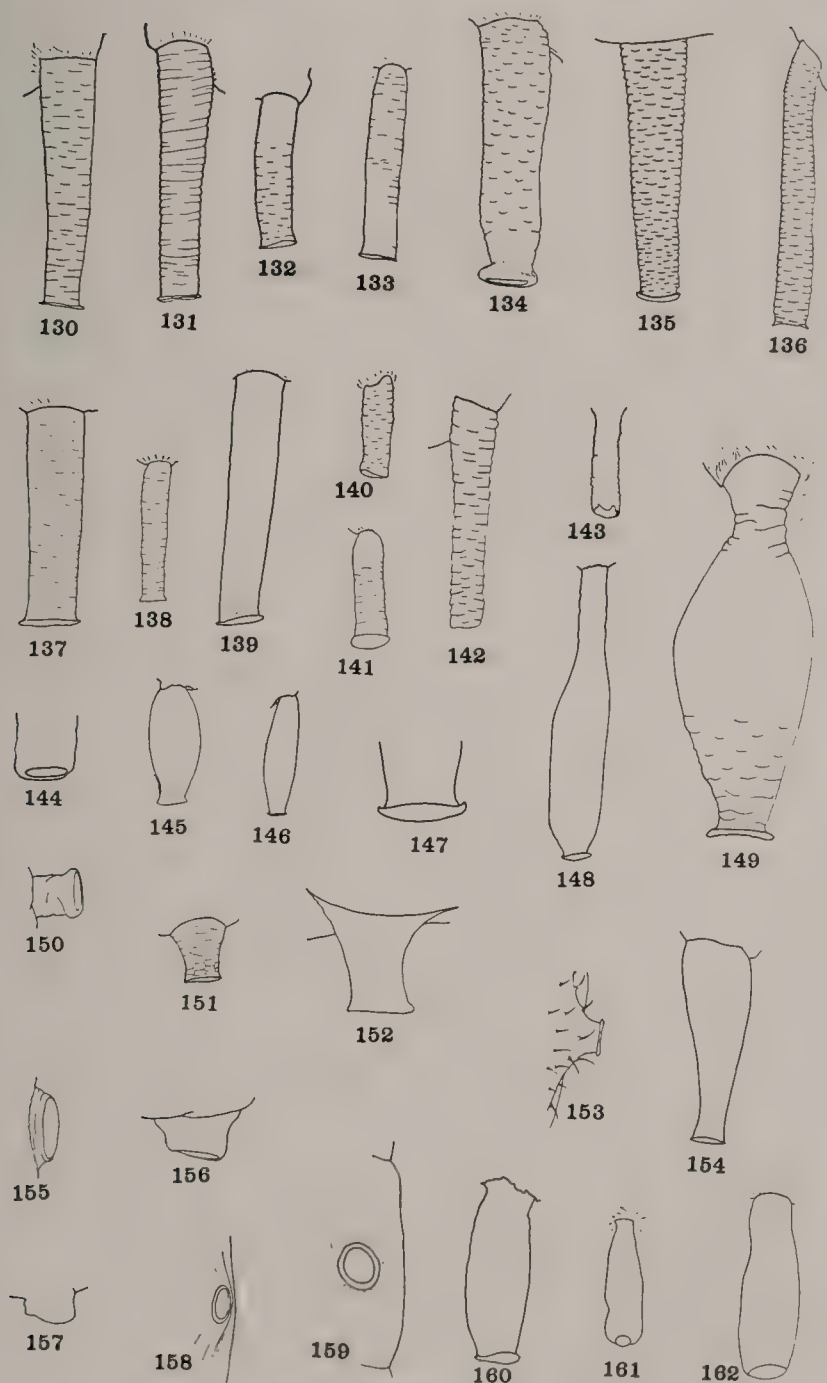


PLATE IV

EXPLANATION OF PLATE V

CAUDAE AND ANAL PLATES

- Fig. 163 *Capitophorus pakansus* Hottes and Frison, cauda, alate viviparous female.
- Fig. 164 *Amphorophora nebulosa* Hottes and Frison, cauda, alate viviparous female.
- Fig. 165 *Macrosiphum adianti* (Oestlund), cauda, alate viviparous female.
- Fig. 166 *Macrosiphum carpinicolens* Patch, apterous viviparous female, fundatrix.
- Fig. 167 *Capitophorus ribis* (Linnaeus), cauda, alate viviparous female.
- Fig. 168 *Myzocallis discolor* (Monell), anal plate, alate viviparous female.
- Fig. 169 *Capitophorus patonkus* Hottes and Frison, cauda, alate viviparous female.
- Fig. 170 *Macrosiphum carpinicolens* Patch, cauda, alate viviparous female.
- Fig. 171 *Macrosiphum illini* Hottes and Frison, cauda, alate viviparous female.
- Fig. 172 *Macrosiphum kickapoo* Hottes and Frison, cauda, alate viviparous female.
- Fig. 173 *Euceraphis betulae* (Koch), anal plate, alate viviparous female.
- Fig. 174 *Capitophorus corambus* Hottes and Frison, cauda, alate viviparous female.
- Fig. 175 *Macrosiphum pallens* Hottes and Frison, cauda, alate viviparous female.
- Fig. 176 *Macrosiphum tapuskae* Hottes and Frison, cauda, apterous viviparous female.
- Fig. 177 *Amphorophora rossi* Hottes and Frison, cauda, alate viviparous female.
- Fig. 178 *Myzocallis discolor* (Monell), cauda, alate viviparous female.
- Fig. 179 *Macrosiphum frigidicola* (Gillette and Palmer), cauda, alate viviparous female.
- Fig. 180 *Macrosiphum anomalae* Hottes and Frison, cauda, alate viviparous female.
- Fig. 181 *Macrosiphum pisi* (Kaltenbach), cauda, alate viviparous female.
- Fig. 182 *Macrosiphum tardae* Hottes and Frison, cauda, alate viviparous female.
- Fig. 183 *Cepegillettea betulaefoliae* Granovsky, cauda, alate viviparous female.
- Fig. 184 *Macrosiphum ambrosiae* (Thomas), cauda, alate viviparous female, lectotype.
- Fig. 185 *Macrosiphum ruralis* Hottes and Frison, cauda, alate viviparous female.
- Fig. 186 *Macrosiphum zinzalae* Hottes and Frison, cauda, alate viviparous female.
- Fig. 187 *Byzus houghtonensis* (Troop), cauda, alate viviparous female, lectotype.
- Fig. 188 *Chaitophorus viminalis* Monell, cauda, alate viviparous female.

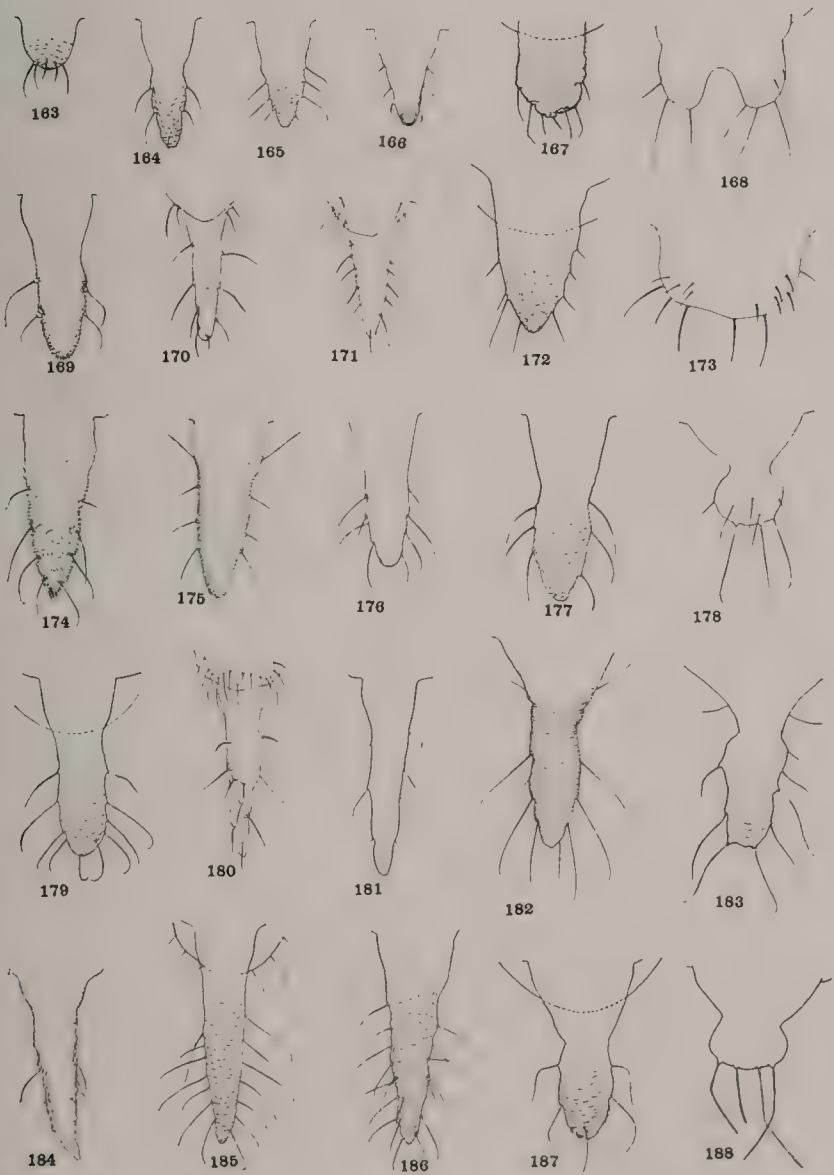


PLATE V

EXPLANATION OF PLATE VI

CAUDAE AND ANAL PLATES

- Fig. 190 *Paducia antennatum* (Patch), cauda, alate viviparous female.
 Fig. 191 *Aphis rociadae* Cockerell, cauda, alate viviparous female.
 Fig. 192 *Cerosipha rubifolii* (Thomas), cauda, alate viviparous female.
 Fig. 193 *Aphis chetansapa* Hottes and Frison, cauda, alate viviparous female.
 Fig. 194 *Aphis zilora* Hottes and Frison, cauda, alate viviparous female.
 Fig. 195 *Aphis carduella* Walsh, cauda, alate viviparous female.
 Fig. 196 *Rhopalosiphum prunifoliae* (Fitch), cauda, alate viviparous female.
 Fig. 197 *Aphis nyctalis* Hottes and Frison, cauda, alate viviparous female.
 Fig. 198 *Aphis illinoisensis* Shimer, cauda, alate viviparous female.
 Fig. 199 *Hyalopterus pruni* (Geoffroy), cauda, alate viviparous female.
 Fig. 200 *Rhopalosiphum enigmae* Hottes and Frison, cauda, alate viviparous female.
 Fig. 201 *Aphis folsomii* Davis, cauda, alate viviparous female.
 Fig. 202 *Aphis caliginosa* Hottes and Frison, cauda and anal plate, alate viviparous female.
 Fig. 203 *Aphis funesta* Hottes and Frison, cauda, alate viviparous female.
 Fig. 204 *Brevicoryne brassicae* Linnaeus, cauda, alate viviparous female.
 Fig. 205 *Asiphonaphis anogis* Hottes and Frison, cauda, alate viviparous female.
 Fig. 206 *Cavariella aegopodii* (Scopoli), cauda and supra-anal process, alate viviparous female.
 Fig. 207 *Rhopalosiphum enigmae* Hottes and Frison, cauda, oviparous female.
 Fig. 208 *Aphis spiraeophila* Patch, cauda, alate viviparous female.
 Fig. 209 *Gypsoaphis oestlundii* Hottes, anal plate, alate viviparous female.
 Fig. 210 *Aphis padi* Linnaeus, anal plate, alate viviparous female.
 Fig. 211 *Neosymydobius memorialis* Hottes and Frison, cauda, alate viviparous female.
 Fig. 212 *Thripsaphis ballii* (Gillette), apical dorsal abdominal segment, cauda, and anal plate, alate viviparous female.
 Fig. 213 *Cinara laricis* (Hartig), anal plate, alate viviparous female.
 Fig. 214 *Plocamaphis terricola* Hottes and Frison, cauda and anal plate, alate viviparous female.
 Fig. 215 *Saltusaphis elongatus* Baker, apical dorsal abdominal segment, cauda, and anal plate, apterous viviparous female.
 Fig. 216 *Cinara laricis* (Hartig), cauda, alate viviparous female.
 Fig. 217 *Drepanaphis acerifoliae* (Thomas), anal plate, alate viviparous female.
 Fig. 218 *Thripsaphis producta* Gillette, apical dorsal abdominal segment, cauda, and anal plate, alate viviparous female.
 Fig. 219 *Saltusaphis wanicus* Hottes and Frison, apical dorsal abdominal segment, cauda, and anal plate, apterous viviparous female.
 Fig. 220 *Calaphis betulella* Walsh, anal plate, alate viviparous female.
 Fig. 221 *Eriosoma lanigera* (Hausmann), cauda and anal plate, alate viviparous female.
 Fig. 222 *Hormaphis hamamelidis* (Fitch), cauda and anal plate, alate viviparous female.

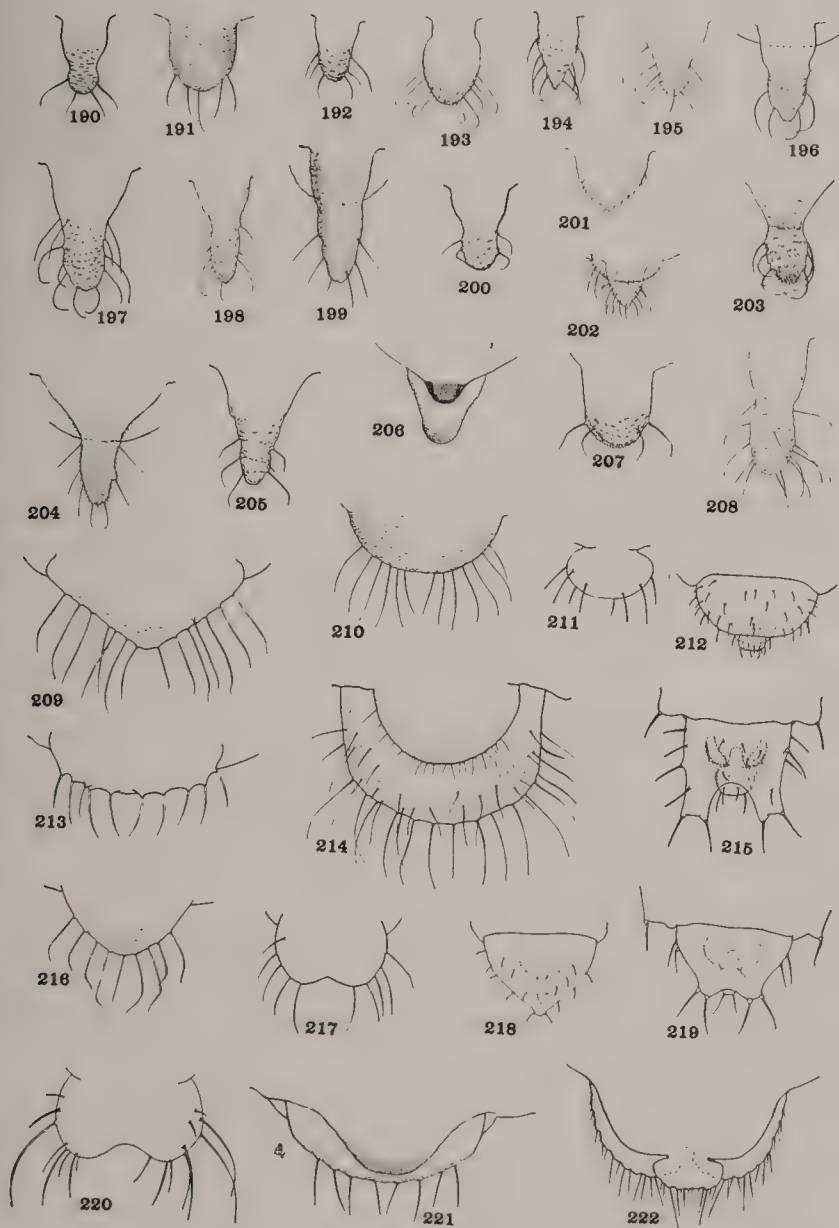


PLATE VI

EXPLANATION OF PLATE VII

ANTENNAE

ALATE VIVIPAROUS FEMALES EXCEPT FIGS. 233 AND 234

- Fig. 223 *Eriosoma mimica* Hottes and Frison, flagellum.
 Fig. 224 *Hormaphis hamamelidis* (Fitch), three-segmented antenna.
 Fig. 225 *Eriosoma lanigera* (Hausmann), third segment.
 Fig. 226 *Georgiaphis ulmi* (Wilson), third segment.
 Fig. 227 *Pemphigus tartareus* Hottes and Frison, sexupara, flagellum.
 Fig. 228 *Pemphigus brevicornis* (Hart), sexupara, flagellum.
 Fig. 229 *Pemphigus ephemeratus* Hottes and Frison, sexupara, flagellum.
 Fig. 230 *Paducia antennatum* (Patch), third and fourth antennal segments.
 Fig. 231 *Cinara difficilis* Hottes and Frison, flagellum.
 Fig. 232 *Sipha flava* (Forbes) five-segmented antenna.
 Fig. 233 *Saltusaphis elongatus* Baker, apterous male, third, fourth, and fifth antennal segments.
 Fig. 234 *Melanocallis fumipennella* (Fitch), alate male, flagellum.
 Fig. 235 *Calaphis castaneae* (Fitch), third segment.
 Fig. 236 *Calaphis betulaecolens* (Fitch), third segment.
 Fig. 237 *Saltusaphis wanicus* Hottes and Frison, third segment.
 Fig. 238 *Neoprociphilus aceris* (Monell), third segment.
 Fig. 239 *Mordwilkoja vagabunda* (Walsh), fundatrigenia, sixth segment.
 Fig. 240 *Pemphigus populi-transversus* Riley, fundatrigenia, sixth segment.
 Fig. 241 *Pemphigus populi-transversus* Riley, sexupara, fifth and sixth segments.
 Fig. 242 *Saltusaphis wanicus* Hottes and Frison, sixth segment.
 Fig. 243 *Drepanaphis acerifoliae* (Thomas), sixth segment.
 Fig. 244 *Tamalia coweni* (Cockerell), sixth segment.
 Fig. 245 *Neosymydobius albasiphus* (Davis), sixth segment.
 Fig. 246 *Melanocallis fumipennella* (Fitch), sixth segment.
 Fig. 247 *Neosymydobius memorialis* Hottes and Frison, sixth segment.
 Fig. 248 *Amphicercidus pulverulens* (Gillette), sixth segment.
 Fig. 249 *Myzocallis alnifoliae* (Fitch), third segment.
 Fig. 250 *Chaitophorus populifoliae* Oestlund, third segment.
 Fig. 251 *Monellia costalis* (Fitch), third segment.
 Fig. 252 *Chaitophorus pusillus* Hottes and Frison, third segment.
 Fig. 253 *Chaitophorus neglectus* Hottes and Frison, third segment.
 Fig. 254 *Neosymydobius annulatus* (Koch), third segment.
 Fig. 255 *Neosymydobius memorialis* Hottes and Frison, flagellum.
 Fig. 256 *Plocamaphis terricola* Hottes and Frison, third segment.

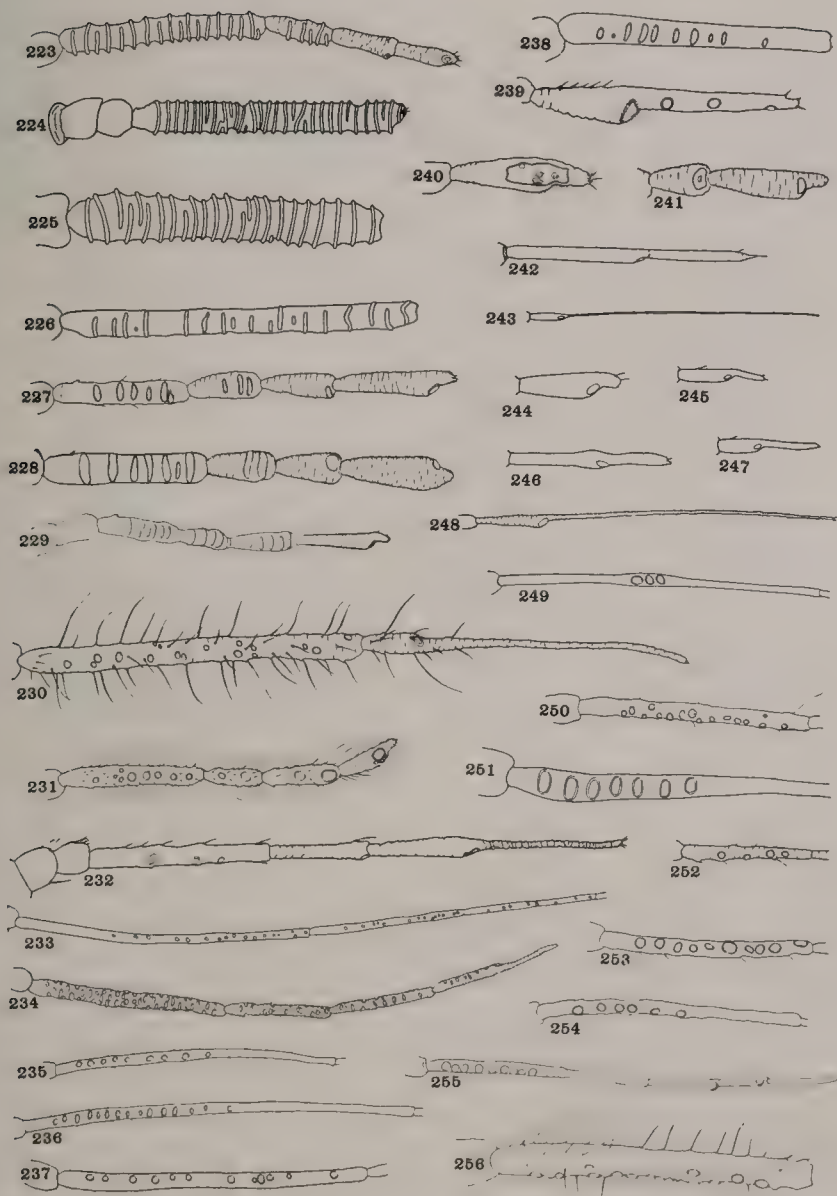


PLATE VII

EXPLANATION OF PLATE VIII

ANTENNAE

Fig. 257 *Capitophorus pakansus* Hottes and Frison, alate viviparous female, third and fourth antennal segments.

Fig. 258 *Capitophorus pakansus* Hottes and Frison, male, third, fourth, and fifth antennal segments.

Fig. 259 *Capitophorus corambus* Hottes and Frison, apterous viviparous female, third antennal segment.

Fig. 260 *Capitophorus corambus* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 261 *Myzus thomasi* Hottes and Frison, alate viviparous female, third, fourth, and fifth antennal segments.

Fig. 262 *Rhopalosiphum enigmae* Hottes and Frison, alate viviparous female, third and fourth antennal segments.

Fig. 263 *Rhopalosiphum enigmae* Hottes and Frison, male, third, fourth, and fifth antennal segments.

Fig. 264 *Myzus thomasi* Hottes and Frison, apterous viviparous female, third, fourth and fifth antennal segments.

Fig. 265 *Aphis signatis* Hottes and Frison, alate viviparous female, third and fourth antennal segments.

Fig. 266 *Aphis nyctalis* Hottes and Frison, alate viviparous female, third, fourth, fifth, and sixth antennal segments.

Fig. 267 *Aphis nyctalis* Hottes and Frison, apterous viviparous female, third and fourth antennal segments.

Fig. 268 *Aphis luridis* Hottes and Frison, alate viviparous female, third, fourth, and fifth antennal segments.

Fig. 269 *Aphis coreopsidis* (Thomas), alate viviparous female, third, fourth, and fifth antennal segments.

Fig. 270 *Asiphonaphis anogis* Hottes and Frison, alate viviparous female, third and fourth antennal segments.

Fig. 271 *Aphis cornifoliae* Fitch, alate viviparous female, third antennal segment.

Fig. 272 *Capitophorus patonkus* Hottes and Frison, apterous viviparous female, third antennal segment.

Fig. 273 *Myzus houghtonensis* (Troop), alate viviparous female, lectotype, third antennal segment.

Fig. 274 *Capitophorus patonkus* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 275 *Cerosipha rubifolii* (Thomas), alate viviparous female, third antennal segment.

Fig. 276 *Aphis pulchella* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 277 *Macrosiphum illini* Hottes and Frison, apterous viviparous female, third and fourth antennal segments.

Fig. 278 *Aphis zilora* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 279 *Aphis carduella* Walsh, alate viviparous female, third antennal segment.

Fig. 280 *Aphis chetansapa* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 281 *Aphis decepta* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 282 *Aphis funesta* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 283 *Hysteroneura setariae* (Thomas), alate viviparous female, third antennal segment.

Fig. 284 *Aphis caliginosa* Hottes and Frison, alate viviparous female, third antennal segment.

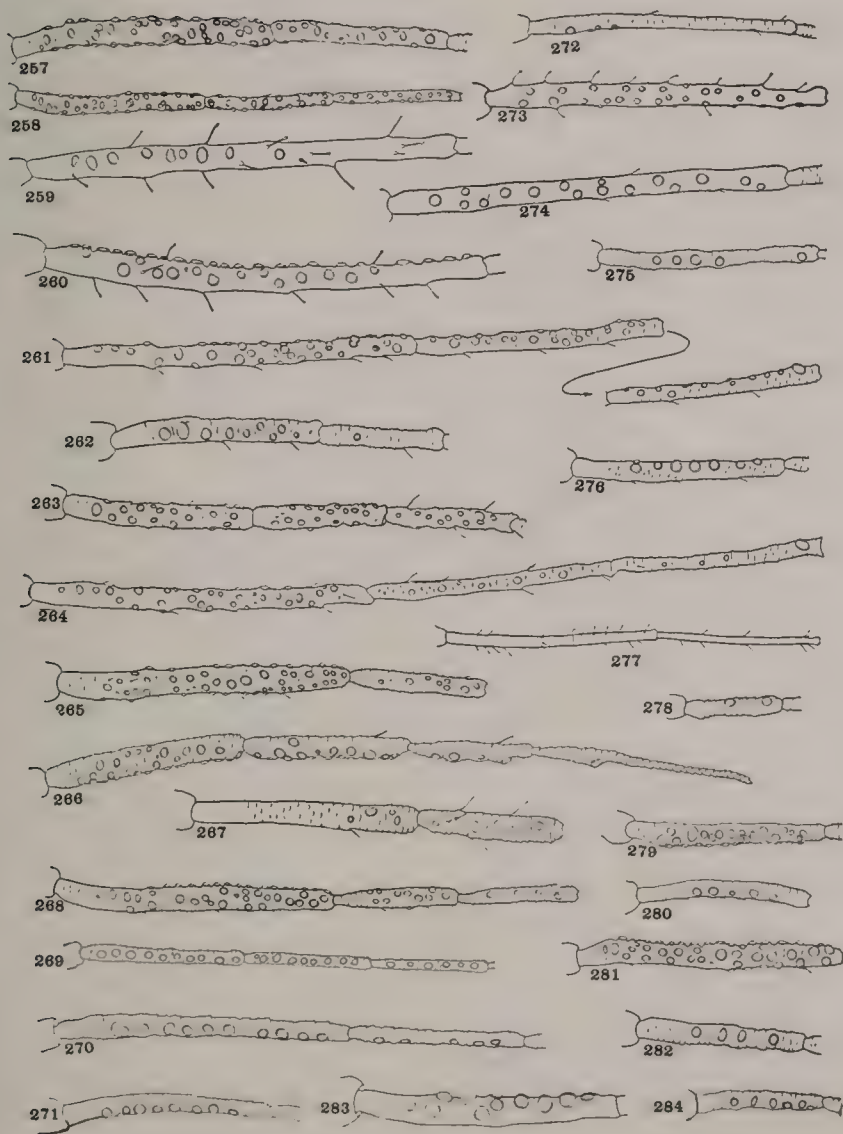


PLATE VIII

EXPLANATION OF PLATE IX

ANTENNAE

Fig. 285 *Macrosiphum illini* Hottes and Frison, male, third, fourth, and fifth antennal segments.

Fig. 286 *Macrosiphum ruralis* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 287 *Macrosiphum sanguinarium* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 288 *Macrosiphum tardae* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 289 *Macrosiphum pallens* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 290 *Macrosiphum zinzalae* Hottes and Frison, apterous viviparous female, third antennal segment.

Fig. 291 *Macrosiphum zinzalae* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 292 *Macrosiphum carpinicolens* Patch, alate viviparous female, third antennal segment.

Fig. 293 *Macrosiphum adianti* (Oestlund), alate viviparous female, third antennal segment.

Fig. 294 *Macrosiphum kickapoo* Hottes and Frison, alate viviparous female, third and fourth antennal segments.

Fig. 295 *Macrosiphum gravicornis* Patch, oviparous female, third antennal segment.

Fig. 296 *Macrosiphum erigeronensis* (Thomas), oviparous female, third antennal segment.

Fig. 297 *Macrosiphum frigidicola* (Gillette and Palmer), alate viviparous female, third antennal segment.

Fig. 298 *Macrosiphum sonchella* (Monell), apterous viviparous female, third and fourth antennal segments.

Fig. 299 *Macrosiphum tapuskae* Hottes and Frison, apterous viviparous female, third antennal segment.

Fig. 300 *Macrosiphum illini* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 301 *Macrosiphum ambrosiae* (Thomas), apterous viviparous female, lectotype, third antennal segment.

Fig. 302 *Macrosiphum ambrosiae* (Thomas), alate viviparous female, lectotype, third antennal segment.

Fig. 303 *Macrosiphum illini* Hottes and Frison, oviparous female, hind tibia.

Fig. 304 *Macrosiphum tapuskae* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 305 *Amphorophora nebulosa* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 306 *Amphorophora singularis* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 307 *Amphorophora rossi* Hottes and Frison, alate viviparous female, third antennal segment.

Fig. 308 *Macrosiphum anomalae* Hottes and Frison, alate viviparous female, third antennal segment.

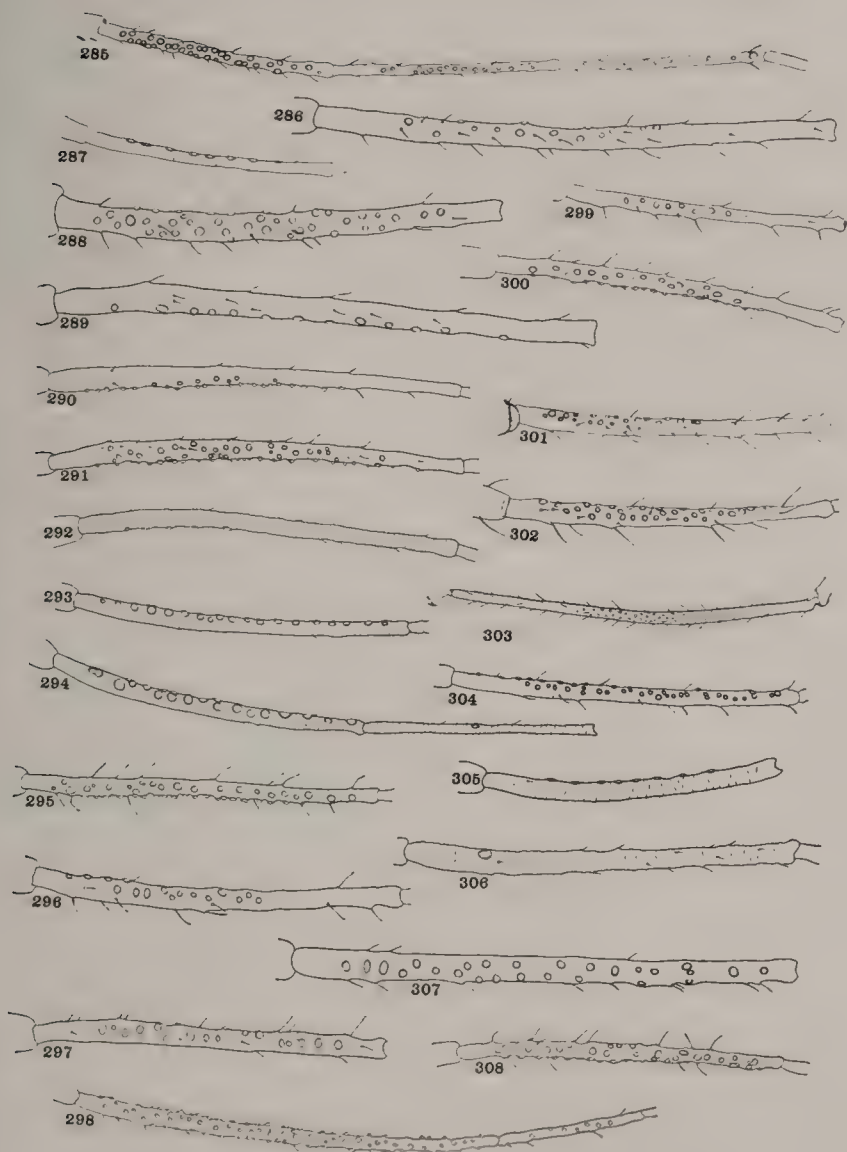


PLATE IX

EXPLANATION OF PLATE X

TUBERCLES, SETAE, ETC.

Fig. 309 *Aphis caliginosa* Hottes and Frison, alate viviparous female, lateral tubercles.

Fig. 310 *Melanocallis fumipennella* (Fitch), alate viviparous female, lateral tubercles.

Fig. 311 *Myzocallis asclepiadis* (Monell), alate viviparous female, lateral tubercles.

Fig. 312 *Asiphonaphis pruni* Wilson and Davis, alate viviparous female, lateral tubercles.

Fig. 313 *Paducia antennatum* (Patch), alate viviparous female, lateral tubercles.

Fig. 314 *Gypsoaphis oestlundii* Hottes, lateral tubercles.

Fig. 315 *Asiphonaphis anogis* Hottes and Frison, apterous viviparous female, lateral tubercles.

Fig. 316 *Iziphyia flabellus* (Sanborn), alate viviparous female, modified setae.

Fig. 317 *Geoica squamosa* Hart, apterous viviparous female, top view of modified setae.

Fig. 318 *Geoica squamosa* Hart, apterous viviparous female, lateral view of modified setae.

Fig. 319 *Tuberculatus punctatellus* (Fitch), alate viviparous female, dorsal abdominal tubercles.

Fig. 320 *Capitophorus fragaefolii* (Cockerell), apterous viviparous female, globose setae.

Fig. 321 *Salтусaphis elongatus* Baker, apterous viviparous female, compound eyes without ocular tubercles.

Fig. 322 *Thripsaphis verrucosa* Gillette, apterous viviparous female, cauda, anal plate and terminal abdominal segment.

Fig. 323 *Drepanaphis monelli* (Davis), alate viviparous female, dorsal abdominal tubercles.

Fig. 324 *Thripsaphis ballii* (Gillette), alate viviparous female, unmodified setae.

Fig. 325 *Shenahweum minutus* (Davis), alate viviparous female, fore femora.

Fig. 326 *Cepigillettea betulaefoliae* Granovsky, alate viviparous female, fore femora.

Fig. 327 *Drepanaphis acerifoliae* (Thomas), alate viviparous female, dorsal abdominal tubercles.

Fig. 328 *Prociphilus venafuscus* (Patch), (sexupara), dorsal wax-pore plates of mesothorax.

Fig. 329 *Prociphilus corrugatus* (Sirriner), (fundatrigenia), dorsal wax-pore plates of mesothorax.

Fig. 330 *Pemphigus populi-transversus* Riley (fundatrigenia), dorsal wax-pore plates of mesothorax.

Fig. 331 *Periphyllus negundinis* (Thomas), dimorphic form.

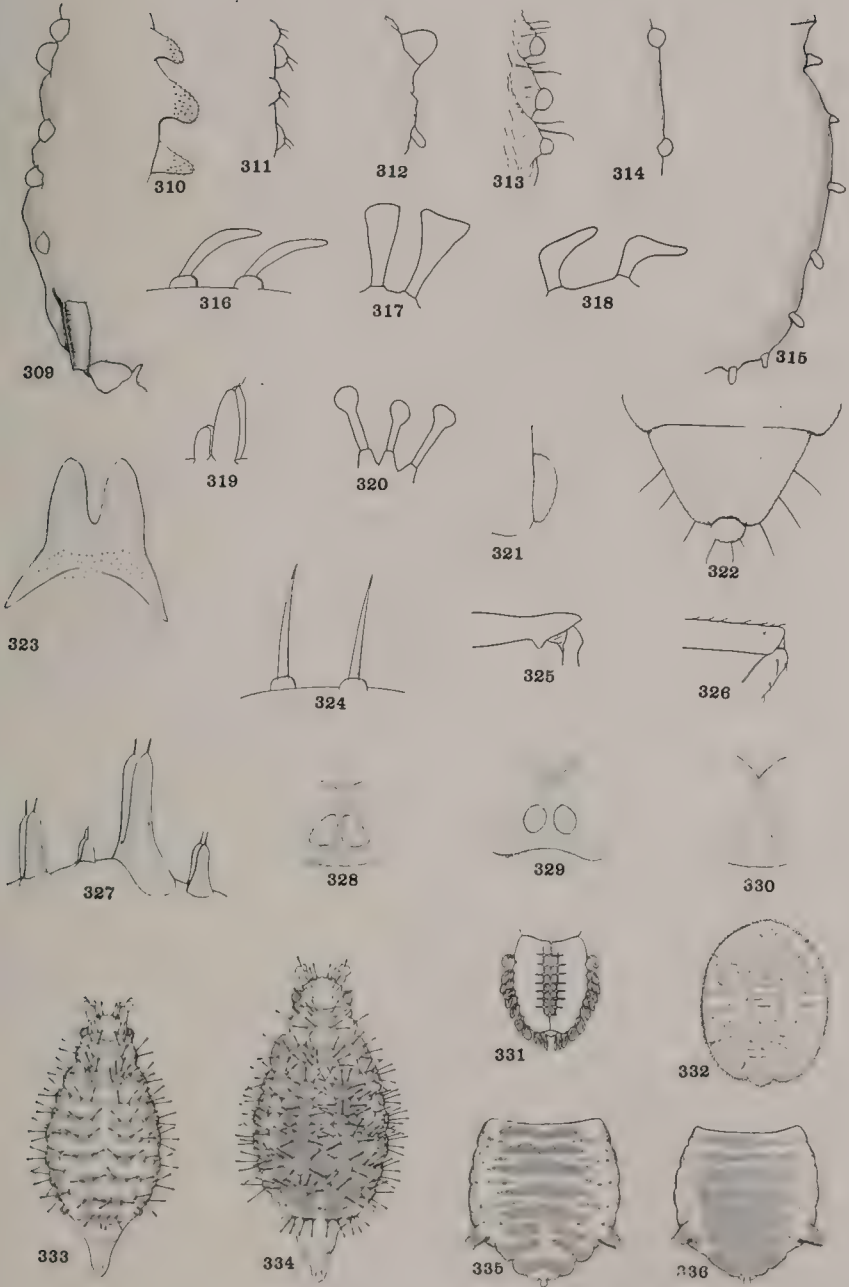
Fig. 332 *Hamamelistes spinosus* Shimer, coccidiform generation.

Fig. 333 *Myzocallis walshii* (Monell), oviparous female, showing color pattern and setal arrangement.

Fig. 334 *Myzocallis alhambra* Davidson, oviparous female, showing color pattern and setal arrangement.

Fig. 335 *Chaitophorus neglectus* Hottes and Frison, alate viviparous female, showing color pattern.

Fig. 336 *Chaitophorus populifoliae* Oestlund, alate viviparous female, showing color pattern.



ADDENDA

SPECIES NOT RECOGNIZED

There exist a few original descriptions of species of aphids, based upon specimens collected in Illinois, which are not recognized in the body of this paper. This situation is due to the fact that to date no one has been able to definitely associate particular species of aphids with these descriptions, probably because of their limitations or vagueness. These descriptions are as follows:

Aphis quercifoliae Walsh, Proc. Ent. Soc. Phil., Vol. 1, No. 9, 1862, p. 298.
Eriosoma? fungicola Walsh, Proc. Ent. Soc. Phil., Vol. 1, No. 9, 1862, p. 304.
Pemphigus formicarius Walsh, Proc. Ent. Soc. Phil., Vol. 1, No. 9, 1862, p. 308.
Pemphigus formicetorum Walsh, Proc. Ent. Soc. Phil., Vol. 1, No. 9, 1862, p. 308.

Siphonophora verbenae Thomas, Bulletin Illinois State Laboratory of Natural History, Vol. 1, No. 2, June, 1878, p. 8.

APHIS SYMPHORICARPI THOMAS

Among the recently recovered types of aphids originally described by Thomas, and not discussed in the body of this article because of their collection in Iowa, are specimens of *Aphis symphoricarpi* Thomas. These cotypic specimens, in poor condition, are mounted on Slides Nos. 2792 and 8776, and the following data are associated with them: Fort Dodge, Iowa, September 1, 1877, on *Symphoricarpus vulgaris*. Both slides contain apterous viviparous females, which may unquestionably be recognized as parasitized specimens of the species now known as *albipes* (Oestlund). The parasitized condition of the specimens accounts for the statements: "Bodies rather broadly ovoid, and very convex. Abdomen distinctly acuminate at the apex, but no tail apparent," which were used in the original description, and for the misleading color notes.

CEDOAPHIS INCOGNITA new name

We find that *Aphis albipes* Oestlund is a synonym of *Aphis symphoricarpi* Thomas. As a result of this synonymy, the species referred to by Oestlund (1922) as *Cedoaphis symphoricarpi* is without a name, and we therefore have proposed *incognita* as a new name for this species.

INDEX

The names of all species and varieties are here listed under the generic names to which the various species have been assigned in this paper, and also in alphabetical order. Those reduced to synonymy, preoccupied, of changed generic assignment, or representing previous Illinois records based upon misidentifications are indicated by *italic* type, and new names by **bold-faced** type.

- abbreviata* Patch, Aphis, 214
abietinus Koch, Mindarus, 374
acerifolii Riley, Pemphigus, 373
acerifoliae (Thomas), Drepanaphis, 246
acerifoliae Thomas, Siphonophora, 246
aceris (Monell), Neoprociphilus, 361
aceris Monell, Pemphigus, 361
adianti (Oestlund), Macrosiphum, 296
adianti Oestlund, Siphonophora, 296
aegopodii Scopoli, Aphis, 229
aegopodii (Scopoli), Cavariella, 229
ageratoidis Oestlund, Aphis, 181
agilis (Kaltenbach), Eulachnus, 157
albasiphus (Davis), Neosymydobius, 261
albasiphus Davis, Symydobius, 261
albifrons Essig, Macrosiphum, 333
albipes Oestlund, Aphis, 438
alhambra Davidson, Myzocallis, 255
alni DeGeer, Aphis, 256
alni (DeGeer), Myzocallis, 256
alnifoliae Fitch, Lachnus, 256
alnifoliae (Fitch), Myzocallis, 256
Alphitopaphis Hottes, 175
lonicericola (Williams), 175
ambrosiae (Thomas), Macrosiphum, 298
ambrosiae Thomas, Siphonophora, 298
americanus (Baker), Neosymydobius, 261
americanus Baker, Symydobius, 261
Amphicercidus Oestlund, 160
pulverulens (Gillette), 160
Amphorophora Buckton, 273
cosmopolitana Mason, 274
laingi Mason, 275
nabali (Oestlund), 275
nebulosa Hottes and Frison, 275
nervata (Gillette), 227
rossi Hottes and Frison, 277
sensoriata Mason, 279
singularis Hottes and Frison, 279
solani (Thomas), 280
vaccinii Mason, 280
ampullata Buckton, Amphorophora, 275
annulatus Koch, Chaitophorus, 262
annulatus (Koch), Neosymydobius, 262
Anoecia Koch, 151
oenotherae Wilson, 151
querci (Fitch), 152
setariae Gillette and Palmer, 151
anogis Hottes and Frison, Asiphonaphis, 225
anomala Hottes and Frison, Macrosiphum, 298
antennata (Patch), Paducia, 168
antennatum Patch, Melanoxantharium, 168
Anuraphis Del Guercio, see Aphis, 176
Aphis Linnaeus, 176
ageratoidis Oestlund, 181
asclepiadis Fitch, 181
bakeri Cowen, 181
caliginosa Hottes and Frison, 182
carduella Walsh, 183
cardui Linnaeus, 185
cephalanthi Thomas, 185
cerasifoliae Fitch, 186
chetansapa Hottes and Frison, 186
coreopsidis (Thomas), 188
cornifoliae Fitch, 189
crataegifoliae Fitch, 190
dehilicornis (Gillette and Palmer), 191
decepta Hottes and Frison, 192
feminea Hottes, 193
folsomii Davis, 193
forbesi Weed, 194
funesta Hottes and Frison, 194
gossypii Glover, 195
helianthi Monell, 196
illinoisensis Shimer, 198
knowltoni Hottes and Frison, 199
laburni Kaltenbach, 199
luridis Hottes and Frison, 200
maculatae Oestlund, 201
maidiradicis Forbes, 202
maidis Fitch, 205
middletonii Thomas, 203
monardae Oestlund, 205
neilliae Oestlund, 205
nerii Fonscolombe, 206
nyctalis Hottes and Frison, 206
oestlundii Gillette, 208
padi Linnaeus, 209
persicae-niger Smith, 209
pomi DeGeer, 210

- pulchella* Hottes and Frison, 212
rhamni Fonscolombe, 214
rociadae Cockerell, 214
rosea Baker, 214
rubicola Oestlund, 215
rumicis Linnaeus, 215
rumicis var. *gerardiae* (Thomas), 217
saliceti Kaltenbach, 217
sambucifoliae Fitch, 218
sanborni Patch, 218
signatis Hottes and Frison, 219
solidaginifoliae Williams, 220
spiraecola Patch, 220
spiraephila Patch, 222
tulipae Fonscolombe, 222
vernoniae Thomas, 222
viburnicola Gillette, 223
viburniphila Patch, 224
zilara Hottes and Frison, 224
apocynii Koch, Aphis, 181
aquaticus Jackson, Rhopalosiphum, 238
aquilegiae Essig, Myzus, 337
arundinis (Fabricius), Hyalopterus, 232
asclepiadis Cowen, Nectarophora, 306
asclepiadis Fitch, Aphis, 181
asclepiadis Monell, Callipterus, 256
asclepiadis (Monell), Myzocallis, 256
Asiphonaphis Wilson and Davis, 225
anogis Hottes and Frison, 225
pruni Wilson and Davis, 227
Asiphum Koch, 348
pseudobyrsa (Walsh), 348
atriplicis Linnaeus, Aphis, 231
atriplicis (Linnaeus), Hyalopterus, 231
attenuatus (Osborn and Serrine), Neoprociphilus, 362
attenuatus Osborn and Serrine, Pemphigus, 362
avenae Fabricius, Aphis, 239
bakeri Cowen, Aphis, 181
ballii Gillette, Brachycolus, 270
ballii (Gillette), Thripsaphis, 270
bella Walsh, Aphis, 257
bella (Walsh), Myzocallis, 257
berberidis Kaltenbach, Aphis, 235
berberidis (Kaltenbach), Rhopalosiphum, 235
betae Doane, Pemphigus, 369
betulae Linnaeus, Aphis, 249
betulae (Linnaeus), Euceraphis, 249
betulaecolens (Fitch), Aphis, 244
betulaecolens (Fitch), Calaphis, 244
betulaefoliae Granovsky, Cepegillettea, 246
betulella Walsh, Calaphis, 244
Brachycolus Buckton, 228
tritici Gillette, 228
braggii Gillette, Myzus, 282
braggii Gillette and Palmer, Plocamaphis, 174
brassicae (Linnaeus), Brevicoryne, 228
brassicae Linnaeus, Aphis, 228
brevicornis (Hart), Pemphigus, 363
brevicornis Hart, Tychea, 363
Brevicoryne Van der Goot, 228
brassicae (Linnaeus), 228
brevis Sanderson, Aphis, 190
Calaphis Walsh, 243
betulaecolens (Fitch), 244
betulella Walsh, 244
castaneae (Fitch), 245
californica (Clarke), Macrosiphum, 314
caliginosa Hottes and Frison, Aphis, 182
Capitophorus Van der Goot, 280
corambus Hottes and Frison, 281
flaveolus (Walker), 282
fragaefolii (Cockerell), 283
gillettei Theobald, 284
minor (Forbes), 284
pakansus Hottes and Frison, 286
patonkus Hottes and Frison, 287
poae (Gillette), 290
ribis (Linnaeus), 290
tetrarhodus (Walker), 291
carduella Walsh, Aphis, 183
cardui Linnaeus, Aphis, 185
carpinicolens Patch, Macrosiphum, 301
caryae Harris, Aphis, 157
caryae (Harris), Longistigma, 157
caryae Monell, Callipterus, 251
caryae (Monell), Monellia, 251
caryae *foliae* Davis, Callipterus, 250
caryella Fitch, Aphis, 252
caryella (Fitch), Monellia, 252
caryella var. *costalis* Fitch, Aphis, 252
castaneae (Fitch), Calaphis, 245
castaneae Fitch, Callipterus, 245
Catamergus Oestlund, see *Macrosiphum*, 293
Cavariella Del Guercio, 229
aegopodii (Scopoli), 229
Cepegillettea Granovsky, 246
betulaefoliae Granovsky, 246
cephalanthi Thomas, Aphis, 185
cerasi Fabricius, Aphis, 335
cerasi (Fabricius), Myzus, 335
cerasicolens (Fitch), Euceraphis, 249
cerasifoliae Fitch, Aphis, 186
cerealis (Kaltenbach), Macrosiphum, 308
Cerosipha Del Guercio, 229
rubifolii (Thomas), 229
Chaitophorus Koch, 160
neglectus Hottes and Frison, 161
populifoliae Oestlund, 163
pusillus Hottes and Frison, 163
quercicola (Monell), 164
viminalis Monell, 165

- chetansapa* Hottes and Frison, Aphis, 186
- chrysanthemi* (Oestlund), Macrosiphum, 302
- chrysanthemi* Oestlund, Siphonophora, 302
- Cinara* Curtis, 153
- difficilis* Hottes and Frison, 153
- laricis* (Hartig), 155
- palmerae* (Gillette), 156
- pini* (Linnaeus), 156
- pinicola* (Kaltenbach), 156
- strobi* (Fitch), 157
- circumflexus* (Buckton), Myzus, 335
- circumflexa* Buckton, Siphonophora, 335
- Clavigerus* Szepligeti, 165
- populifoliae* (Fitch), 165
- smithiae* (Monell), 166
- Colopha* Monell, 348
- graminis* (Monell), 348
- ulmicola* (Fitch), 349
- Colophella* Börner, see *Colopha*, 348
- Colorado* Wilson, 241
- corambus* Hottes and Frison, Capitophorus, 281
- coreopsidis* (Thomas), Aphis, 188
- coreopsidis* Thomas, Siphonophora, 188
- corni* auct., Anoecia, 152
- cornicola* Walsh, Eriosoma (?), 152
- cornifoliae* Fitch, Aphis, 189
- corrugatans* Serrine, Pemphigus, 370
- corrugatans* (Serrine), Prociphilus, 370
- coryli* Davis, Macrosiphum, 303
- coryli* Goeze, Aphis, 257
- coryli* (Goeze), Myzocallis, 257
- cosmopolitana* Mason, Amphorophora, 274
- costalis* (Fitch), Monellia, 252
- coveni* Cockerell, Pemphigus, 268
- coveni* (Cockerell), Tamalia, 268
- crataegi* (Monell), Macrosiphum, 304
- crataegi* Monell, Siphonophora, 304
- crataegi* (Oestlund), Eriosoma, 351
- crataegi* Oestlund, Schizoneura, 351
- crataegifoliae* Fitch, Aphis, 190
- Cryptomyzus* van der Goot, see *Capitophorus*, 280
- cucumeris* Forbes, Aphis, 195
- cucurbitae* Thomas, Siphonophora, 306
- cynosbati* (Oestlund), Myzus, 316
- davisi* Patch, Aphis, 201
- debilicornis* Gillette and Palmer, Anuraphis, 191
- debilicornis* (Gillette and Palmer), Aphis, 191
- decepta* Hottes and Frison, Aphis, 192
- dentatus* Le Baron, Lachnus, 159
- difficilis* Hottes and Frison, Cinara, 153
- diospyri* Thomas, Aphis, 142
- dirhodum* Walker, Aphis, 304
- dirhodum* (Walker), Macrosiphum, 304
- discolor* Monell, Callipterus, 258
- discolor* (Monell), Myzocallis, 258
- Drepanaphis* Del Guercio, 246
- acerifoliae* (Thomas), 246
- keshenae* Granovsky, 248
- monelli* (Davis), 249
- claeagni* Del Guercio (Davis), Myzus, 283
- eleusinis* Thomas, Rhizobius, 152
- elongata* Baker, Saltusaphis, 265
- enigmae* Hottes and Frison, Rhopalosiphum, 235
- enigmae* var. *parvae* Hottes and Frison, Rhopalosiphum, 237
- ephemeratus* Hottes and Frison, Pemphigus, 365
- eragrostidis* Middleton, Colopha, 349
- erigeronensis* (Thomas), Macrosiphum, 304
- erigeronensis* (Thomas), Prociphilus, 371
- erigeronensis* Thomas, Siphonophora, 304
- erigeronensis* Thomas, Tychea, 371
- Eriosoma* Leach, 350
- crataegi* (Oestlund), 351
- lanigera* (Hausmann), 351
- mimica* Hottes and Frison, 353
- rileyi* Thomas, 354
- essigi* Gillette and Palmer, Chaitophorus, 163
- essigi* Gillette and Palmer, Myzus, 337
- Euceraaphis* Walker, 249
- betulae* (Linnaeus), 249
- Eulachnus* Del Guercio, 157
- rileyi* (Williams), 157
- euphorbiae* Thomas, Siphonophora, 306
- euphorbicola* Thomas, Siphonophora, 306
- evansi* Theobald, Amphorophora, 278
- fagi* Linnaeus, Aphis, 264
- fagi* (Linnaeus), Phyllaphis, 264
- feminea* Hottes, Aphis, 193
- flabella* (Sanborn), Iziphya, 250
- flabellus* Sanborn, Chaitophorus, 250
- flaveola* Walker, Aphis, 282
- flaveolus* (Walker), Capitophorus, 282
- flava* (Forbes), Siphia, 174
- flavus* Forbes, Chaitophorus, 174
- flocculosum* Weed, Melanoxanthus, 173

- flocculosus* (Weed), *Plocamaphis*, 173
folsomii Davis, *Aphis*, 193
forbesi Weed, *Aphis*, 194
Forda Heyden, 354
 occidentalis Hart, 356
 olivacea Rohwer, 356
formicaria Heyden, *Forda*, 356
formicarius Walsh, *Pemphigus*, 438
formicetorum Walsh, *Pemphigus*, 438
formosana Takahashi, *Amphorophora*, 280
fragaefolii (Cockerell), *Capitophorus*, 283
fragaefolii Cockerell, *Myzus*, 283
fragariae Theobald, *Myzus*, 283
fragariae var. *immaculata* Riley, *Macrosiphum*, 284
fraxinifolii Riley, *Pemphigus*, 371
fraxinifolii Thomas, *Pemphigus*, 372
fraxinifolii (Riley), *Prociphilus*, 371
frigidicola Gillette and Palmer, *Macrosiphoniella*, 305
frigidicola (Gillette and Palmer), *Macrosiphum*, 305
frondosae Oestlund, *Aphis*, 181
fumipennella Fitch, *Aphis*, 250
fumipennella (Fitch), *Melanocallis*, 250
funesta Hottes and Frison, *Aphis*, 194
fungicola Walsh, *Eriosoma*(?), 438

galeopsidis (Kaltenbach), *Phorodon*, 284
gei (Koch), *Macrosiphum*, 306
gei Koch, *Siphonophora*, 306
Geica Hart, 356
 squamosa Hart, 356
Georgiaphis Maxson and Hottes, 357
ulmi (Wilson), 357
geranii (Oestlund), *Macrosiphum*, 307
geranii Oestlund, *Nectarophora*, 307
gerardiae Thomas, *Siphonophora*, 217
gillettei Maxson and Hottes, *Georgia*, 357
gillettei Theobald, *Capitophorus*, 284
gladioli Felt, *Aphis*, 222
Gobaishia Matsumura, 359
 ulmi-fusus (Walsh and Riley), 359
gossypii Glover, *Aphis*, 195
granaria Kirby, *Aphis*, 308
granarium (Kirby), *Macrosiphum*, 308
graminis (Monell), *Colopha*, 348
graminis Monell, *Tetraneura*, 348
graminum Rondani, *Aphis*, 241
graminum (Rondani), *Toxoptera*, 241
gravicornis Patch, *Macrosiphum*, 308
gravicornis Patch, *Thecabius*, 374
Gypsoaphis Oestlund, 167
 oestlundii Hottes, 167

hamamelidis Fitch, *Brysocrypta*, 376
hamamelidis (Fitch), *Hormaphis*, 376

Hamamelistes Shimer, 375
 spinosus Shimer, 375
helianthi Oestlund, *Aphis*, 191
helianthi Monell, *Aphis*, 196
helichrysi Kaltenbach, *Aphis*, 209
heucherae (Thomas), *Myzus*, 337
heucherae Thomas, *Siphonophora*, 337
Hormaphis Osten Sacken, 376
 hamamelidis (Fitch), 376
houghtonensis Troop, *Aphis*, 338
houghtonensis (Troop), *Myzus*, 338
howardii Wilson, *Amphorophora*, 240
humuli Schrank, *Aphis*, 345
humuli (Schrank), *Phorodon*, 345
Hyadaphis Kirkaldy, see *Rhopalosiphum*, 234
Hyalopterus Koch, 231
 atriplicis (Linnaeus), 231
 hyperici (Monell), 232
 pruni (Geoffroy), 232
hypeici Thomas, *Myzocallis*, 232
hyperici Monell, *Aphis*, 232
hyperici (Monell), *Hyalopterus*, 232
hyperici Thomas, *Myzocallis*, 232
Hysteroneura Davis, 232
 setariae (Thomas), 232

Idiopterus Davis, 292
 nephrolepidis Davis, 292
 violae (Pergande), 292
illini Hottes and Frison, *Macrosiphum*, 309
illini var. *crudae* Hottes and Frison, *Macrosiphum*, 311
illini var. *sangamonensis* Hottes and Frison, *Macrosiphum*, 312
Illinoia Wilson, see *Macrosiphum*, 293
illinoisensis Shimer, *Aphis*, 198
imbricator Fitch, *Eriosoma*, 372
imbricator (Fitch), *Prociphilus*, 372
impatiensicolens Patch, *Macrosiphum*, 312
impatiens Thomas, *Aphis*, 185
incognita Hottes and Frison, *Cedoaphis*, 438
inulae (Walker), *Capitophorus*, 287
Iziphyia Nersky, 250
 flabella (Sanborn), 250

Kakimia Hottes and Frison, 344
keshenae Granovsky, *Drepanaphis*, 248
kickapoo Hottes and Frison, *Macrosiphum*, 312
knowltoni Hottes and Frison, *Aphis*, 199

laburni Kaltenbach, *Aphis*, 199
Lachnus Burmeister, see *Cinara*, 153
lactucae Fitch, *Pemphigus*, 364
lactucae (Linnaeus), *Siphonophora*, 338
lactucae Schrank, *Aphis*, 338

- lactucae* (Schrank), Myzus, 338
laevigatae Essig, Macrosiphum, 314
laingi Mason, Amphorophora, 275
lanigera Hausmann, Aphis, 351
lanigera (Hausmann), Eriosoma, 351
laricifex Fitch, Lachnus, 156
laricis (Hartig), Cinara, 155
laricis Hartig, Lachnus, 155
laricis Walker, Aphis, 155
Liosomaphis Walker, see *Rhopalosiphum*, 234
liriodendri (Monell), Macrosiphum, 314
liriodendri Monell, Siphonophora, 314
loniceræ Monell, Aphis, 167
lonicericola Williams, Aphis, 175
lonicericola (Williams), Alphitoaphis, 175
Longistigma Wilson, 157
 caryae (Harris), 157
ludovicianæ (Oestlund), Macrosiphum, 315
ludovicianæ Oestlund, Siphonophora, 315
luridis Hottes and Frison, Aphis, 200
lutescens Monell, Aphis, 206
lyropictus Kessler, Chaitophorus, 170
lyropictus (Kessler), Periphyllus, 170

maculatae Oestlund, Aphis, 201
Macrosiphum Passerini, 293
 adianti (Oestlund), 296
 ambrosiæ (Thomas), 298
 anomalæ Hottes and Frison, 298
 carpinicolens Patch, 301
 chrysanthemi (Oestlund), 302
 coryli Davis, 303
 crataegi (Monell), 304
 dirhodum (Walker), 304
 erigeronensis (Thomas), 304
 frigidicola (Gillette and Palmer), 305
 gei (Koch), 306
 geranii (Oestlund), 307
 granarium (Kirby), 308
 gravicornis Patch, 308
 illini Hottes and Frison, 309
 illini var. *crudæ* Hottes and Frison, 311
 illini var. *sangamonensis* Hottes and Frison, 312
 impatiensicolens Patch, 312
 kickapoo Hottes and Frison, 312
 laevigatae Essig, 314
 liriodendri (Monell), 314
 ludovicianæ (Oestlund), 315
 pallens Hottes and Frison, 315
 pisi (Kaltenbach), 317
 pseudorosæ Patch, 318
 ptericolens Patch, 318
 purpurascens (Oestlund), 318
 ribellum Davis, 319
 rosæ (Linnaeus), 320
 rudbeckiæ (Fitch), 320
 ruralis Hottes and Frison, 321
 sanborni Gillette, 323
 sanguinarium Hottes and Frison, 323
 schranksi Theobald, 326
 sonchellum (Monell), 326
 tapuskæ Hottes and Frison, 327
 taraxaci (Kaltenbach), 329
 tardæ Hottes and Frison, 329
 tiliæ (Monell), 331
 venaefuscae Davis, 332
 zinzalæ Hottes and Frison, 332
Macrosiphoniella Del Guercio, see *Macrosiphum*, 293
madia Swain, Macrosiphum, 333
maidi-radici Forbes, Aphis, 202
maidis Fitch, Aphis, 205
mali Fabricius, Aphis, 210
malifoliæ Fitch, Aphis, 214
medicaginis Koch, Aphis, 199
Melanocallis Oestlund, 250
 fumipennella (Fitch), 250
Melaphis Walsh, 359
 rhois (Fitch), 359
mellifera Hottes, Hyadaphis, 238
melliferum Hottes, Rhopalosiphum, 238
memorialis Hottes and Frison, Neosymydobius, 262
Microparsus Patch, 333
 variabilis Patch, 333
middletonii Thomas, Aphis, 203
middletonii Knowlton, Chaitophoroides, 199
mimica Hottes and Frison, Eriosoma, 353
Mindarus Koch, 374
 abietinus Koch, 374
minor (Forbes), Capitophorus, 284
minor Forbes, Siphonophora, 284
minutus Baker, Melaphis, 360
minutus Davis, Drepanaphis (?), 268
minutum (Davis), Shenaweum, 268
monardæ Oestlund, Aphis, 205
monardæ (Williams), Myzus, 339
monardæ Williams, Phorodon, 339
monardæ (Williams), Rhopalosiphum, 339
monelli (Davis), Drepanaphis, 249
monelli Davis, Phymatosiphum, 249
Monellia Oestlund, 251
 caryae (Monell), 251
 caryella (Fitch), 252
 costalis (Fitch), 252
 nigropunctata Granovsky, 252
Mordwilkoja Del Guercio, 360
 vagabunda (Walsh), 360
Myzocallis Passerini, 254
 alhambra Davidson, 255
 alni (DeGeer), 256
 alnifoliæ (Fitch), 256
 asclepiadis (Monell), 256

- bella* (Walsh), 257
coryli (Goeze), 257
discolor (Monell), 258
ononidis (Kaltenbach), 258
punctata (Monell), 259
tiliae (Linnaeus), 259
walshii (Monell), 259
Myzus Passerini, 334
cerasi (Fabricius), 335
circumflexus (Buckton), 335
essigi Gillette and Palmer, 337
heucherae (Thomas), 337
houghtonensis (Troop), 338
lactucae (Schränk), 338
monardae (Williams), 339
persicae (Sulzer), 339
plantagineus Passerini, 340
porosus Sanderson, 340
serophulariae (Thomas), 343
thomasi Hottes and Frison, 343
naabali (Oestlund), Amphorophora, 275
naabali Oestlund, Rhopalosiphum, 275
nebulosa Hottes and Frison, Amphorophora, 275
neglectus Hottes and Frison, Chaitophorus, 161
negundinis Thomas, Chaitophorus, 170
negundinis (Thomas), Periphyllus, 170
neilliae Oestlund, Aphis, 205
Neomyzus Van der Goot, see *Myzus*, 334
Neoprociphilus Patch, 361
aceris (Monell), 361
attenuatus (Osborn and Serrine), 362
Neosymydobius Baker, 261
albasiphus (Davis), 261
americanus (Baker), 261
annulatus (Koch), 262
memorialis Hottes and Frison, 262
Neothomasia Baker, see *Periphyllus*, 170
nephrolepidis Davis, Idiopterus, 292
nerii Fonscolombe, Aphis, 206
nervata (Gillette), Amphorophora, 277
nervatum Gillette, Rhopalosiphum, 277
nigrae Oestlund, Chaitophorus, 165
nigronervosa Coquerel, Pentalonia, 345
nigropunctata Granovsky, Monellia, 252
nyctalis Hottes and Frison, Aphis, 206
nymphaeae Linnaeus, Aphis, 238
nymphaeae (Linnaeus), Rhopalosiphum, 238
oblongus Heyden, Symydobius, 261
occidentalis Hart, Forda, 356
oenotherae Oestlund, Aphis, 208
oenotherae Wilson, Anoecia, 151
oestlundii Gillette, Aphis, 208
oestlundii Hottes, Gypsoaphis, 167
olivacea Rohwer, Forda, 356
ononidis Kaltenbach, Aphis, 258
ononidis (Kaltenbach), Myzocallis, 258
padi Linnaeus, Aphis, 209
Paducia Hottes and Frison, 167
antennata (Patch), 168
pakansus Hottes and Frison, Capitophorus, 286
pallens Hottes and Frison, Macrosiphum, 315
pallida (Oestlund), Macrosiphum, 318
pallida (Walker), Macrosiphum, 318
palmerae (Gillette), Cinara, 156
palmerae Gillette, Lachnus, 156
panici Thomas, Tychea, 143
panicola Thomas, Schizoneura, 152
parvae Hottes and Frison, Rhopalosiphum enigmae var., 237
pastinacae Davis, Hyadaphis, 229
patonkus Hottes and Frison, Capitophorus, 287
pelargonii (Kaltenbach), Macrosiphum, 316
Pemphigus Hartig, 363
brevicornis (Hart), 363
ephemeratus Hottes and Frison, 365
populicaulis Fitch, 366
populi-transversus Riley, 367
populi-venae Fitch, 368
rubi Thomas, 368
tartareus Hottes and Frison, 369
Pentalonia Coquerel, 345
nigronervosa Coquerel, 345
Periphyllus Van der Hoeven, 170
lyopictus (Kessler), 170
negundinis (Thomas), 170
populicola (Thomas), 172
persicae Sulzer, Aphis, 339
persicae (Sulzer), Myzus, 339
persicae-niger Smith, Aphis, 209
phaseoli (Passerini), Trifidaphis, 374
phaseoli Passerini, Tychea, 374
Phorodon Passerini, 345
humuli (Schränk), 345
Phyllaphis Koch, 264
fagi (Linnaeus), 264
pini Linnaeus, Aphis, 156
pini (Linnaeus), Cinara, 156
pinicola (Kaltenbach), Cinara, 156
pinicola Kaltenbach, Lachnus, 156
pinicola Thomas, Schizoneura, 374
pisi Kaltenbach, Aphis, 317
pisi (Kaltenbach), Macrosiphum, 317

- plantagineus* Passerini, Myzus, 340
Plocamaphis Oestlund, 172
 flocculosa (Weed), 173
 terricola Hottes and Frison, 173
poae (Gillette), Capitophorus, 290
poae Gillette, Rhopalosiphum, 290
poae Thomas, Rhizobius, 142
pomi DeGeer, Aphis, 210
populella Gillette and Palmer, Chaitophorus, 163
populicaulis Fitch, Pemphigus, 366
populicola Thomas, Chaitophorus, 172
populicola (Thomas), Periphyllus, 172
populifoliae Davis, Aphis, 202
populifoliae Fitch, Aphis, 165
populifoliae (Fitch), Clavigerus, 165
populifoliae Knowlton, Chaitophoroides, 199
populifoliae Oestlund, Chaitophorus, 163
populi-transversus Riley, Pemphigus, 367
populi-venae Fitch, Pemphigus, 368
porosus Sanderson, Myzus, 340
Prociophilus Koch, 370
 corrugatus (Sirrinc), 370
 erigeronensis (Thomas), 371
 fraxinifolii (Riley), 371
 imbricator (Fitch), 372
 tessellata (Fitch), 373
 venafuscus (Patch), 373
producta Gillette, Thripsaphis, 270
pruni Geoffroy, Aphis, 232
pruni Geoffroy, Hyalopteris, 232
pruni Koch, Aphis, 185
pruni Wilson and Davis, Asiphonaphis, 227
prunifoliae Fitch, Aphis, 185, 239
prunifoliae (Fitch), Rhopalosiphum, 239
pseudobrassicæ Davis, Aphis, 240
pseudobrassicæ (Davis), Rhopalosiphum, 240
pseudobyrsa (Walsh), Asiphum, 348
pseudobyrsa Walsh, Byrsocrypta, 348
pseudorosæ Patch, Macrosiphum, 318
ptericolens Patch, Macrosiphum, 318
pulchella Hottes and Frison, Aphis, 212
pulverulens (Gillette), Amphicercidus, 160
pulverulens Gillette, Aphis, 160
punctata Monell, Callipterus, 259
punctata (Monell), Myzocallis, 259
punctatella Fitch, Aphis, 271
punctatella (Fitch), Tuberculatus, 271
punctatus (Burmeister), Tuberolachnus, 159
purpurascens (Oestlund), Macrosiphum, 318
purpurascens Oestlund, Nectarophora, 318
pusillus Hottes and Frison, Chaitophorus, 163
pyri Fitch, Pemphigus, 370
querci (Fitch), Anoecia, 152
querci Fitch, Eriosoma, 152
quercicola Monell, Callipterus (?), 164
quercicola (Monell), Chaitophorus, 164
quercicola Baker, Phyllaphis, 268
quercicola (Baker), Stegophylla, 268
quercifoliae Walsh, Aphis, 438
radicicola Essig, Tychea, 374
radicola Oestlund, Tychea, 371
rhamni Fonscolombe, Aphis, 214
rhois Monell, Rhopalosiphum, 240
rhois Fitch, Byrsocrypta, 359
rhois (Fitch), Melaphis, 359
Rhopalosiphum Koch, 234
 berberidis (Kaltenbach), 235
 enigmæ Hottes and Frison, 235
 enigmæ var. *parvæ* Hottes and Frison, 237
 melliferum Hottes, 238
 nymphaeae (Linnaeus), 238
 prunifoliae (Fitch), 239
 pseudobrassicæ (Davis), 240
 rhois Monell, 240
 rufomaculatum (Wilson), 241
ribiellum Davis, Macrosiphum, 319
ribis Linnaeus, Aphis, 290
ribis (Linnaeus), Capitophorus, 290
rileyi Thomas, Eriosoma, 354
rileyi (Williams), Eulachnus, 157
rileyi Williams, Lachnus, 157
rociadæ Cockerell, Aphis, 214
rosæ Linnaeus, Aphis, 320
rosæ (Linnaeus), Macrosiphum, 320
rosarum (Kaltenbach), Myzus, 283
rosea Baker, Anuraphis, 214
rosea (Baker), Aphis, 214
rossi Hottes and Frison, Amphorophora, 277
rubecula Haldeman, Aphis, 215
rubri Thomas, Pemphigus, 368
rubicola Oestlund, Aphis, 215
rubicunda (Wilson), Cinara, 155
rubifolii (Thomas), Cerosipha, 229
rubifolii Thomas, Siphia, 229
rubiphila Patch, Aphis, 215
rudbeckiæ Fitch, Aphis, 320
rudbeckiæ (Fitch), Macrosiphum, 320
rufa Monell, Macrosiphum *liriodendri* var., 315
rufomaculatum (Wilson), Rhopalosiphum, 241
rumicis Linnaeus, Aphis, 215

- ruralis* Hottes and Frison, Macrosiphum, 321
- salicicola* Thomas, Siphonophora, 217
- saliceti* Kaltenbach, Aphis, 217
- saligna* Gmelin, Aphis, 159
- saligna* (Gmelin), Tuberolachnus, 159
- Saltusaphis* Theobald, 265
- elongata* Baker, 265
- wanica* Hottes and Frison, 266
- sambuci* Linnaeus, Aphis, 218
- sambucifoliae* Fitch, Aphis, 218
- sanborni* Patch, Aphis, 218
- sanborni* Gillette, Macrosiphum, 323
- sanguinarium* Hottes and Frison, Macrosiphum, 323
- schranksi* Theobald, Macrosiphum, 326
- scrophulariae* (Thomas), Myzus, 343
- scrophulariae* Thomas, Phorodon, 343
- senecionis* Williams, Aphis, 208
- sensoriata* Mason, Amphorophora, 279
- setariae* Gillette and Palmer, Anoecia, 151
- setariae* (Thomas), Hysteroneura, 232
- setariae* Thomas, Siphonophora, 232
- Shenahweum* Hottes and Frison, 267
- minutum* (Davis), 268
- signatis* Hottes and Frison, Aphis, 219
- similis* Van der Goot, Capitophorus, 287
- singularis* Hottes and Frison, Amphorophora, 279
- Sipha* Passerini, 174
- flava* (Forbes), 174
- smithiae* Monell, Chaitophorus, 166
- smithiae* (Monell), Clavigerus, 166
- solani* (Thomas), Amphorophora, 280
- solani* Thomas, Megoura, 280
- solanifolii* (Ashmead), Macrosiphum, 306
- solidaginifoliae* Williams, Aphis, 220
- sonchellum* (Monell), Macrosiphum, 326
- sonchella* Monell, Siphonophora, 326
- sonchi* Davis, Rhopalosiphum, 274
- sorbi* Kaltenbach, Aphis, 214
- spicatus* Hart, Rhizobius, 348
- spinosus* Oestlund, Chaitophorus, 164
- spinosus* Shimer, Hamamelistes, 375
- spiraecola* Patch, Aphis, 211, 220
- spiraecella* Schouteden, Aphis, 211, 220
- spiraephila* Patch, Aphis, 222
- squamosa* Hart, Geolca, 356
- Stegophylla* Oestlund, 268
- quercicola* (Baker), 268
- strobi* (Fitch), Cinara, 157
- strobi* Fitch, Eriosoma, 157
- symphoricarpi* Oestlund, Cedoaphis, 438
- symphoricarpi* Thomas, Aphis, 142, 438
- symphoricarpi* (Thomas), Thargelia, 142
- Tamalia* Baker, 268
- coweni* (Cockerell), 268
- tapuskae* Hottes and Frison, Macrosiphum, 327
- taraxaci* Kaltenbach, Aphis, 329
- taraxaci* (Kaltenbach), Macrosiphum, 329
- tardae* Hottes and Frison, Macrosiphum, 329
- tartareus* Hottes and Frison, Pemphigus, 369
- terricola* Hottes and Frison, Plocamaphis, 173
- tessellata* Fitch, Eriosoma, 373
- tessellata* (Fitch), Prociphilus, 373
- tetrarhoda* Walker, Aphis, 291
- tetrarhodus* (Walker), Capitophorus, 291
- Tetraneura*, see *Colopha*, 348
- Thecabius* Koch, 374
- gravicornis* Patch (?), 374
- species* (?), 374
- Therioaphis* Walker, see *Myzocallis*, 254
- thomasi* Hottes and Frison, Myzus, 343
- Thomasia* Wilson, 172
- Thripsaphis* Gillette, 270
- ballii* (Gillette), 270
- producta* Gillette, 270
- verrucosa* Gillette, 271
- tiliae* Linnaeus, Aphis, 259
- tiliae* (Linnaeus), Myzocallis, 259
- tiliae* (Monell), Macrosiphum, 331
- tiliae* Monell, Siphonophora, 331
- Toxoptera* Koch, 241
- graminum* (Rondani), 241
- tritici* Gillette, Brachycolus, 228
- trifolii* Monell, Callipterus, 258
- Trifidaphis* Del Guercio, 374
- phaseoli* (Passerini), 374
- tuberculata* Patch, Aphis, 193
- Tuberculatus* Mordvilko, 271
- punctatella* (Fitch), 271
- ulmifolii* (Monell), 272
- Tuberolachnus* Mordvilko, 159
- saligna* (Gmelin), 159
- tulipae* Fonscolombe, Aphis, 222
- tulipae* Thomas, Rhopalosiphum, 339
- ulmi* (Linnaeus), Eriosoma, 353
- ulmi* Riley, Eriosoma, 354
- ulmi* Wilson, Georgia, 357
- ulmi* (Wilson), Georgiaphis, 357
- ulmicola* (Fitch), Colopha, 349
- ulmicola* Fitch, Byrsocrypta, 349
- ulmicola* Thomas, Callipterus, 272
- ulmifolii* Monell, Callipterus, 272
- ulmifolii* (Monell), Tuberculatus, 272

- ulmi-fusus* (Walsh and Riley), *Gobaishia*, 359
ulmi-fusus Walsh and Riley, *Pemphigus*, 359
urticae Schrank, *Aphis*, 326
utricularia (Passerini), *Geocica*, 357
vaccinii Mason, *Amphorophora*, 280
vagabunda Walsh, *Byrsocrypta*, 360
vagabunda (Walsh), *Mordwilkoja*, 360
variabilis Patch, *Microparsus*, 333
venaefuscae Davis, *Macrosiphum*, 332
venafuscus Patch, *Pemphigus*, 373
venafuscus (Patch), *Prociphilus*, 373
verbenae Thomas, *Siphonophora*, 143, 438
vernoniae Thomas, *Aphis*, 222
verrucosa Gillette, *Thripsaphis*, 271
viburni Scopoli, *Aphis*, 224
viburnicola Gillette, *Aphis*, 223
viburniphila Patch, *Aphis*, 224
viminalis Monell, *Chaitophorus*, 165
vincae Gillette, *Myzus*, 336
violae Pergande, *Rhopalosiphum*, 292
violae (Pergande), *Idiopterus*, 292
violae Theobald, *Neotoxoptera*, 292
viticola Thomas, *Siphonophora*, 198
vitidis (?) Scopoli, *Aphis*, 199
walshii Monell, *Callipterus*, 259
walshii (Monell), *Myzocallis*, 259
wanica Hottes and Frison, *Saltusaphis*, 266
xylostei Schrank, *Aphis*, 238
xylostei (Schrank), *Rhopalosiphum*, 238
zilora Hottes and Frison, *Aphis*, 224
zinzalae Hottes and Frison, *Macrosiphum*, 332

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

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THEODORE H. FRISON, *Chief*

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The Plankton of Some Sink Hole Ponds in Southern Illinois

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THE PLANKTON OF SOME SINK HOLE PONDS IN SOUTHERN ILLINOIS

SAMUEL EDDY

Sink holes are abundant in various parts of Illinois, especially in the extreme southern portion of the state. Their circular or oval funnels are common in areas underlain with limestone. The general conception of their origin is that water moving through the limestone dissolves away part of it so as to form underground chambers, the roofs of which settle and cause surface depressions that become filled with water draining from the surrounding land. Cummings (1905) advanced the idea that the majority of sink holes, particularly those of southern Indiana, were only enlarged funnels produced by the penetration of surface waters into the limestone, and according to this idea such bodies of water have been referred to sometimes as "solution ponds." The sink holes studied in this paper, however, were probably produced by the first method, which is the more generally accepted among geologists.

All such sinks originally have no other drainage than a vertical pit in the center extending to the subterranean outlet. The younger sinks are usually small and deep with steep sides extending to the pit. In the older sinks drainage from the pit is obstructed by falling rocks and eroded soil, so that the water accumulates to form a pond, though drainage is frequently maintained to some extent through the pit. As a result of further erosion of the sides and deposition of the silt washed in after each rain, the pond gradually fills and becomes only a low place containing water in wet seasons.

The water from these sinks is generally considered as a source of supply to underground streams and springs. Kofoed (1899) states that the sink holes in the vicinity of Mammoth Cave, Kentucky, supply the water for the cave streams and the surrounding surface springs. All of the twenty organisms that he found in the water of Echo River in Mammoth Cave seemed to be characteristic of the surface waters and to originate from ponds in connected sink holes. Plankton organisms were rare in Echo River, and only six of those found were true pond forms. Scott (1909) found that the underground streams in the vicinity of Shawnee Cave in southern Indiana were similarly fed

by water from sink holes and that the plankton of these streams originated in the ponds on the surface. Scott (1911) observed the fauna of a sink hole pond in southern Indiana over a period of several years and reported a faunal list containing a few plankton organisms.

A study of the plankton of such ponds is of interest because of the additional information thus obtained regarding pond organisms and because of the possibilities of their relation to cave fauna. Also, as the ponds may be the sources of the large springs for which these regions are noted and often popular, the contents of their waters are important as possible sources of pollution.



Sketch map showing location of ponds (1-6) and spring (7). Scale: $2\frac{1}{2}$ inches equals 1 mile.

The ponds studied by the writer are located three-fourths of a mile northwest of Wetaug, Illinois, on the farm of Mr. R. Wiard in Pulaski County. The Lower Mississippian limestone which underlies this region contains many caves, and the numbers of its subterranean passages are indicated by the numbers of springs in the valleys. More than a dozen large sinks filled with water and many others small and empty are to be found within a radius of one-half mile from the ponds studied. The larger sinks contain water at all seasons of the year. During the rainy seasons the level rises a few feet but soon drops to normal.

PERENNIAL PONDS

Three perennial ponds of different sizes were selected for study. They are indicated by the numbers 1, 2, and 3 on the accompanying map. Mr. Wiard stated that by probing through the ice he had found a pit in the center of each. The largest pond (No. 1), located one-eighth mile north of Mr. Wiard's house, is probably the oldest of the group studied. The sides have eroded, enlarging the boundaries of the pond until it covers about five acres, and the deposition of the eroded clay has filled the bottom so that it slopes very gradually to a depth of 20 feet in the center. No vegetation is apparent except a few small willows. The next largest pond (No. 2), about 150 feet in diameter, lies about 300 feet south of the house. Clay has washed in until the bottom slopes gradually to a depth of about 20 feet in the center. There is no vegetation about this pond. The smallest and deepest, and therefore youngest, pond (No. 3) lies southwest of the house. It is about 75 feet in diameter with a steep mud bottom sloping to a reported depth of about 40 feet. Half of this pond is shaded by oak trees on the west bank.

Silk-net collections were made from Pond No. 1 on April 17, 1927, and again on April 16, 1928. In these preliminary collections the following forms were found:

<i>Lysigonium varians</i> (Ag.) D. T.	occasional
<i>Synedra ulna</i> (Nitz.) Ehr.	occasional
<i>Coelosphaerium kuetzingianum</i> Näg.	rare
<i>Spirogyra</i> spp.	common
<i>Netrium digitus</i> (Ehr.) Itz. & Roth.	very abundant
<i>Closterium acerosum</i> (Schrank) Ehr.	very abundant
<i>Pleurotaenium</i> sp.	common
<i>Micrasterias americana</i> (Ehr.)	common
<i>Diffugia urceolata</i> Carter.	occasional
<i>Diffugia globulosa</i> Duj.	occasional
<i>Dinobryon sertularia</i> Ehr.	common
<i>Eudorina elegans</i> Ehr.	common
<i>Volvox globator</i> Leeuwenhoek.	common
<i>Rotaria neptunia</i> (Ehr.)	rare
<i>Conochiloides dossuarius</i> (Hudson)	occasional
<i>Polyarthra trigla</i> Ehr.	common
<i>Trichocerca multicrinis</i> (Kellicott)	common
<i>Lecane unguolata</i> (Gosse)	occasional
<i>Keratella cochlearis</i> (Gosse)	abundant
<i>Notholca longispina</i> (Kellicott)	rare
<i>Diaphanosoma brachyurum</i> (Liéven)	occasional
<i>Bosmina longirostris</i> (O. F. M.)	abundant
<i>Alona</i> sp.	rare
<i>Chydorus sphaericus</i> (O. F. M.)	common
<i>Diaptomus mississippiensis</i> Marsh	common
<i>Cyclops bicuspidatus</i> Claus	abundant
Copepods (immature)	common

Table IV shows the results obtained from collections made from Ponds Nos. 1, 2, and 3 in July, September, and December, 1928, and in April, 1929. Usually filter-paper collections were made simultaneously with the silk-net collections and used to furnish data on the smaller planktonts. The abundance of the organisms was determined by the usual counting method in a Sedgwick-Rafter slide.

Some of the chemical conditions of the ponds were determined in an effort to find any differentiating factors which might influence plankton distribution. Water samples collected December 1, 1928, were submitted to the Illinois State Water Survey for determination of the chlorine in chlorides and of alkalinity; determinations of the dissolved oxygen content were made September 12 and December 1, 1928; and temperature and pH readings were taken on several occasions (Table I). From these limited data on chemical and physical condi-

TABLE I
PHYSICAL AND CHEMICAL DATA ON PONDS NOS. 1, 2, AND 3

Date 1928	Determination	No. 1	No. 2	No. 3
Dec. 1	Chlorine in chlorides, p. p. m.....	16	0	1
Dec. 1	Alkalinity, phenolphthalein, p. p. m....	0	0	0
Dec. 1	Alkalinity, methyl orange, p. p. m....	24	10	10
July 20	Temperature, C.	29	29	28
Sept. 2	Temperature, C.	26	26	26
Dec. 1	Temperature, C.	9	9	9
July 20	Hydrogen ion concentration, pH.....	6.6	6.6	6.8
Sept. 3	Hydrogen ion concentration, pH.....	7.1	7.6	7.4
Sept. 3	Dissolved oxygen, cc. per liter.....	4.443	4.998	3.605
Dec. 1	Dissolved oxygen, cc. per liter.....	6.424	6.118	5.659

tions, there seems to be little difference in the waters of the various ponds. Some variations occur, but they are not as great as those often found between two streams with the same type of fauna. The dissolved salt content is partially indicated by the determination of the chlorine in chlorides. This factor was negligible in Ponds No. 2 and No. 3 but quite noticeable in Pond No. 1. It is obvious that the origin of the dissolved salts is in the soil washed by the water draining into the ponds, since the only apparent source of the water of the ponds is rain water from the surrounding basins or slopes. Pond No. 1 not only occupies a larger area but has a much larger drainage basin in proportion than the other ponds studied. Consequently, as the water of this pond was subject to more soil wash, it would be expected to have a greater dissolved salt content.

These three ponds contained a rich plankton. Many more species were found than were recorded by Scott (1911). A total of 128 species was found in the plankton of the three ponds. With slight differences in the lists, 81 species occurred in the north pond (No. 1) the same number in the south pond (No. 2), while the southwest pond (No. 3) had 90 species (Table II). As far as volume was concerned, there was little difference between the total amount of plankton in each pond. The silk-net collections for July and September averaged 18 cc. per cubic meter, and the filter-paper collections for the same dates averaged 183 cc. per cubic meter. The species which were common to all the ponds usually were those which were abundant in each. The exceptions to this will be discussed later. There were no greater differences in species or in their abundance in the collections of the same date from the three ponds than often occur in collections made simultaneously at short distances from each other in the same pond or

TABLE II
NUMBERS OF SPECIES FOUND IN PONDS NOS. 1, 2, AND 3

Organisms	No. 1	No. 2	No. 3
Algae	33	30	31
Protozoa	21	16	25
Nematoda	0	1	1
Rotatoria	17	20	20
Cladocera	5	9	9
Copepoda	4	3	4
Ostracoda	0	1	0
Insecta	1	1	0
Total	81	81	90

stream. Thirty-seven species were common to the three ponds, and there may have been others which were overlooked because of small numbers. All of these were species characteristic of pond plankton. The most abundant were *Trachelomonas volvocina*, *Peridinium cinctum*, *Codonella cratera*, *Polyarthra trigla*, *Keratella cochlearis*, *Bosmina longirostris*, *Cyclops viridis*, and *Cyclops bicuspidatus*. These are cosmopolitan forms, commonly found in nearly all bodies of fresh water. The plankton thus was characterized by the presence of certain species abundantly distributed in all the ponds and by the absence or scarcity of other species.

Diatoms, usually so abundant in pond and stream plankton, were noticeably rare. *Synedra ulna* was the only diatom found in all the ponds. *Synedra tenuissima* and species of *Fragilaria* and *Lysigonium*, usually found in bodies of fresh water, were either absent or relatively

scarce. Pearsall (1923) has noted that a lack of essential mineral elements may be responsible for the decreased diatom population in the plankton of ponds, and that an increase in mineral content usually occurred after rains and was accompanied by an increase in diatoms. It is interesting to note that two common species of the typical plankton genus *Lysigonium* occurred in Pond No. 1, which was the only pond with an appreciable dissolved salt content as indicated by the determination of the chlorine in chlorides, and bottom diatoms were particularly abundant in the small temporary pools occupying the basins of the filled sinks, where the water was generally greatly reduced by evaporation and it is possible that the dissolved salt content may have been rather large.

Algae, especially the blue-green forms, were usually abundant. In July and September, Ponds No. 1 and No. 2 contained a rich population of blue-greens. Pond No. 3, which was deeper and ecologically younger, did not have these forms in any abundance. *Coclosphaerium nacygelianum*, *Anabaena planktonica*, and *A. spiroides* formed a bloom on the first two ponds in July and September. The total number of species of algae found in the three ponds was 52.

The common phytoplanktons of the genera *Scenedesmus* and *Pediastrum* were never as abundant as in rivers and in ponds generally.

Most of the species of rotifers are those which are quite common in rivers and ponds generally, but several were noted which were characteristic of these sinks. *Trichocerca multicrinis* occurred in all the ponds but was much more abundant in the north pond (No. 1) most of the time. Although occasionally found elsewhere in Illinois, this species does not usually occur as abundantly or as uniformly as it did here. It was seldom absent from a collection and was always abundant in one or more of the ponds.

Rotifers of the genus *Synchaeta* were entirely absent, and those of the genus *Brachionus* were very scarce with the exception of *Brachionus patulus*, which is hardly a typical species. Both of these genera usually form a characteristic part of the plankton of ponds and large rivers, and their scarcity here constitutes a negative character of the plankton. This may be due in part to a lack of necessary mineral elements or to a slight temporary acidity of the water (Harring and Myers, 1928). As collections were made from three ponds, it is hardly possible that these rotifers could have been abundant in any pond between the dates of collections. In many southern waters in the State of Mississippi, in Reelfoot Lake in Tennessee (Eddy, 1930), and in the floodplain lakes a few miles to the south of the sink holes under discussion, the writer has found most species of the genus *Brachionus* to be rare. In many ponds and lakes in the

central part of Illinois and in the Illinois and Rock rivers, these forms are very abundant and often are characteristic of the plankton. Information on the geographical distribution of these circum-polar and supposedly cosmopolitan rotifers is not sufficient to establish their range definitely, but their rarity in southern collections makes it seem possible that they have a southern limit.

Thirty-one species of Protozoa were found in the three ponds. The common pond types, such as *Ceratium hirundinella* and *Codonella cratera*, were well distributed. The plankton was further characterized by the rather unusual abundance of various species of *Trachelomonas* and of *Peridinium cinctum*. *Trachelomonas volvocina* was abundant at all times. An unusually interesting form was found in *Trachelomonas magdaleniana*, which was described by Deflandre (1926) from a single specimen from Venezuela, but never reported, as far as is known, from any other place. This species was found commonly in Ponds No. 2 and No. 3 in the summer of 1928, and in various other waters of the southern part of Illinois during the same season.

Copepods were very common. *Cyclops viridis* was observed in most of the collections. *Cyclops bicuspidatus* occurred as a spring form in the April collections. *Diaptomus mississippiensis*, generally regarded as a southern species, appeared as a spring form in Pond No. 1 in 1928 and in all the ponds in April, 1929.

TEMPORARY PONDS IN OLD SINK HOLES

Random collections were made also from three small sink holes (see 4, 5, and 6 on the map) which contained shallow temporary pools having an abundance of vegetation, chiefly grasses and cat-tails. These were old sinks that had filled with clay until they had become very shallow. There was no longer any evidence of any pit or underground drainage. Such pools, therefore, have no influence on the subterreanean waters.

A small pool (No. 5), near Pond No. 1, contained a heavy red bloom of *Euglena sanguinea* July 29, 1928. As the water was only about six inches deep, the plankton was highly concentrated. Bottom diatoms constituted half of the bulk of the forms present. Protozoa, especially the chlorophyll-bearing forms, constituted the other half. This aggregation of organisms can hardly be called plankton, because the pool was so shallow that they were practically living on the bottom. Nevertheless, except for the bottom diatoms, they were forms which are found normally in plankton. Algae were scarce. The plankton here included six forms not found at this time in Pond No. 1: two rotifers (*Monostyla quadridentata* and *Lepadella acuminata*), three

protozoans (*Euglena sanguinea*, *Euglena viridis*, and *Pleodorina illinoensis*), and one alga (*Cosmarium depressum*). This pool was dry September 3, 1928.

Another similar pool (No. 6), near Pond No. 3, also had a heavy red bloom of *Euglena sanguinea* and contained an abundance of diatoms. Only a few other species, however, were found here. *Arcella vulgaris*, usually a bottom form, was abundant, though it did not appear in the collections from the nearby perennial pond (No. 3).

Another small sink hole (No. 4), near Pond No. 1, contained a temporary pool 2 feet deep and 20 feet in diameter in April and July, 1928. This sink was dry in September, 1928. At the time of collecting, the organisms were not as concentrated as in the other temporary pools but represented many more species. The data of this pool are not listed, as they are very similar to those of Pond No. 1 for the same date. They comprise 35 species, all of which occurred in the nearby pond (No. 1) at the same times. It is interesting to note that this temporary pool was slightly deeper than the other temporary pools and that the plankton here resembled that of the larger perennial ponds rather than that of the smaller temporary pools.

TABLE III
COUNTS OF ORGANISMS PER CUBIC METER FROM TEMPORARY PONDS NOS. 5 AND 6

Organisms	Pond No. 5 July 20, 1928	Pond No. 6 Sept. 3, 1928
Undetermined diatoms	12,000,000,000	20,000,000,000
<i>Cosmarium depressum</i> (Näg.)	3,000,000	.....
<i>Spirogyra</i> sp.	10,000,000	.....
<i>Arcella vulgaris</i> Ehr.	10,000,000	10,000,000
<i>Diffugia lobostoma</i> Leidy	2,000,000	.....
<i>Euglena sanguinea</i> Ehr.	1,000,000,000	10,000,000,000
<i>Euglena spirogyra</i> Ehr.	80,000,000	.....
<i>Trachelomonas ensifera</i> Daday	3,000,000	.....
<i>Trachelomonas volvocina</i> Ehr.	1,000,000	50,000,000
<i>Trachelomonas hispida</i> (Perty) .....	.....	30,000,000
* <i>Pleodorina illinoensis</i> Kofoid	50,000,000	.....
<i>Peridinium</i> sp.	40,000,000	.....
<i>Polyarthra trigla</i> Ehr. ....	.....	1,000,000
<i>Lepadella acuminata</i> (Ehr.) .....	.....	6,000,000
<i>Monostyla quadridentata</i> Ehr.	2,000,000	.....
<i>Brachionus patulus</i> O. F. M.	1,000,000	.....

* Colonies.

The plankton of all these temporary remnants of old ponds contained the same species of organisms as were found at some time or other in the younger and deeper permanent ponds, with the exception of *Euglena sanguinea* and *E. spirogyra*, which formed the bloom.

RELATION OF SINK HOLE PONDS TO SPRINGS

As Scott and Kofoid found that underground waters in the regions of sink holes were contaminated by surface pond organisms, an attempt was made to ascertain if there was any evidence that the springs of this locality were connected with the surface ponds. The most accessible spring (No. 7 on the map) was located on the road one-fourth mile from Wetaug and one-half mile from the sink holes. Plankton collections were made from this spring on October 12, 1928. Only a few organisms were found, twelve of which were identified. These are listed below, with average counts of their abundance per cubic meter:

<i>Surirella robusta</i> Ehr.....	800
Undetermined diatoms	400
<i>Oscillatoria</i> sp. (filaments).....	40,000
<i>Arcella vulgaris</i> Ehr.....	2,400
<i>Diffugia acuminata</i> Ehr.	320
Nematodes	16
<i>Cyclops viridis</i> Jurine.....	1,600
<i>Cyclops serrulatus</i> Fischer.....	3,200
Immature copepods	4,800
Chironomid larvae	160
* <i>Filinia longiseta</i> (Ehr.)	16
* <i>Brachionus angularis</i> Gosse	15
* <i>Keratella cochlearis</i> (Gosse)	18

Nine of these were living and, with the exception of *Cyclops serrulatus* (a temporary pond copepod), could occur naturally in either the spring or in the sink hole ponds. The other three, which were rare and partly disintegrated, were rotifers: *Filinia longiseta*, *Brachionus angularis*, and *Keratella cochlearis*, all of which also occurred in the collections from the sink hole ponds. None of these three forms would be expected to live under normal conditions in a spring. It would be difficult to determine whether this spring was connected with the particular ponds studied. The use of dyes in the ponds could not be attempted in this brief study. The presence of the three battered rotifers mentioned may be accepted as probable evidence of the origin of the water from these or similar ponds. The other species were either typical of springs or tolerant of the conditions under which they were found.

CONCLUSIONS

An abundant plankton was found in the sink hole ponds studied. It was of the same general composition in all of the perennial ponds,

* Partly disintegrated plankton organisms belonging to pond plankton.

exhibiting only minor variations, which consisted chiefly in the presence of a few species, usually inconspicuous, in one pond that were apparently absent in another.

The plankton of these ponds, though similar in some respects to that of rivers and of other ponds, is distinguished by the abundance of several characteristic species, such as *Trichocerca multirinis*, and by the absence or scarcity of certain other species, notably rotifers of the genus *Brachionus* which normally occur in pond plankton.

The ponds ranged in age, both geologically and ecologically, from a deep perennial pond in an apparently recent sink hole to temporary ponds in old sink holes that had become nearly filled. Though differing in their depths and areas, the perennial ponds all contained the same type of plankton; that is, the predominant forms in each pond were largely of the same kinds. Two of the temporary ponds contained plankton which differed distinctly from that of the perennial ponds. In a third temporary pond, which was deeper and apparently younger, the plankton was more like that of the perennial ponds. Some of the species common to the perennial ponds were retained in all these temporary ponds, but they were mingled with bottom species to form a characteristic aggregation which may be called plankton only in a broad sense.

To a certain extent, this series shows developmental stages in the trend of the plankton community as the ponds grow old and gradually fill. As long as a pond remains in the perennial stage, containing water throughout the year, the plankton shows little change, but as the depth decreases and the pond reaches the temporary stage, containing water only in the rainy seasons, the plankton organisms mingle with those from the bottom in an aggregation characteristic of very shallow water. At this stage it is interesting to note how tenacious of their habitat certain pond planktons are, for they persist almost as long as there is water left in which they can swim. Ultimately these aggregations disappear before an invasion of shore and vegetation organisms as the pond becomes merely a wet depression in a terrestrial habitat.

There is incomplete evidence that the plankton population of nearby springs is derived from ponds in sink holes. This is important because in many cases farm buildings are located on the slopes draining into the sink holes and could easily pollute the waters forming the source for nearby springs.

Each of the perennial ponds contained an abundance of algae of numerous species, which seemed to balance the heavy animal popula-

tion. Thus the plankton community was apparently self-supporting with regard to producers and consumers.

Sink hole ponds, because of their relative stability in regard to water level and plankton content and because of their small size, should offer an interesting opportunity for further study on the dynamics of aquatic communities.

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TABLE IV
ABUNDANCE OF PLANKTON ORGANISMS PER CUBIC METER IN PONDS NOS. 1, 2, AND 3
Counts of organisms in filter-paper collections are given in *italics*; those in silk-net collections are given in roman type.
All counts are of cells or unit organisms except those marked by the asterisk, which are of colonies or filaments.

Organisms	Pond	July 20, 1928	Sept. 3, 1928	Dec. 1, 1928	Apr. 3, 1929
BACILLARIACEAE					
Lysionium granulatum (Ehr.) Kuntze.....	1	.....	165,000	1,000,000	.....
Synedra tenuissima Kütz.....	3	.....	.....	9,200	.....
	1	.....	.....	.....	9,900
	2	.....	.....	.....	33,330
Synedra ulna (Nitz.) Ehr.....	3	772	.....	.....	72,000
	1	260	.....	.....	350
Navicula spp.	2	130	.....	.....	.....
	1	.....	.....	.....	330
Surirella robusta Ehr.....	3	.....	.....	920	.....
CYANOPHYCEAE					
Chroococcus spp.*	1	.....	990,000	.....	.....
	2	.....	.....	.....	367,700
	3	.....	7,722	.....	.....
Coelosphaerium kuetszingianum Näg.*.....	1	14,220,800	26,70,000	300,000	135,000
Coelosphaerium naegelianum Unger*.....	2	13,332,000	477,730	14,670,000	666,600
	1	177,760	660,000	20,000	.....
Microcystis flos-aquae (Wittrock) Kirehner*.....	2	.....	2,400,000	144,400	.....
	3	11,583	.....	.....	.....
	2	44,400	3,200	.....	.....
Microcystis aeruginosa Kütz.*.....	3	.....	6,000	.....	.....
Microcystis incerta Lemm.*.....	2	133,200	.....	.....	.....
	1	1,066,510	330,000	.....	27,000
Aphanocapsa spp.*	2	465,000	23,886,500	.....	.....
	3	1,930	.....	.....	.....
Anabaena planktonica Brunnthaler.....	1	17,776,000	29,700,000	400,000	.....
	2	22,220,000	7,105,950	.....	.....
Anabaena spiroides var. crassa Lemm.....	1	1,777,600	.....	.....	.....
	2	39,996,000	4,777,300	.....	.....
Anabaena circinalis (Kütz.) Raben.....	2	620,000	1,331,900	.....	.....
	1	21,331,200	24,750,000	400,000	.....
Aphanizomenon flos-aquae (L.) Itals.....	2	20,300,200	4,433,190	.....	.....

CHLOROPHYCEAE

<i>Botryococcus sudeticus</i> Lemm.*	1	.....	.....	.....	1,650
	2	.....	.....	.....	3,300
	3	.....	.....	.....	4,000
<i>Dietyosphaerium pulchellum</i> Wood*	1	.....	33,000	.....	.....
	2	372,000	5,332,800	.....	.....
	1	.....	.....	270	.....
<i>Treubaria crassispina</i> G. M. S.	2	.....	.....	320	.....
	3	.....	46,662	.....	.....
	1	260	33,000	.....	.....
<i>Tetraedron trigonum</i> (Näg.) Hansgörg.	2	.....	95,546	.....	.....
	3	1,544	46,662	27,775	.....
<i>Tetraedron gracile</i> (Reinsch) Hansgörg.	1	520	1,400	.....	.....
	3	772	.....	.....	.....
<i>Tetraedron lobulatum</i> (Näg.)	1	.....	66,000	.....	.....
	2	.....	17,773	.....	.....
<i>Lagerheimia</i> sp.	1	.....	1,910,920	.....	.....
	2	.....	990,000	4,000,000	.....
<i>Ankistrodesmus falcatus</i> (Corda) Ralfs.	1	.....	475,530	888,800	.....
	2	.....	2,333,100	277,550	.....
	3	.....	466,620	9,721,250	.....
<i>Closteriopsis longissima</i> Lemm.	1	386	.....	.....	.....
<i>Crucigenia irregularis</i> Wille.	2	.....	320	.....	.....
<i>Scenedesmus dimorphus</i> (Turpin) Kütz.	1	.....	1,399,860	138,875	.....
<i>Scenedesmus bifuga</i> (Turpin) Lagerheim.	2	7,722	466,620	.....	.....
<i>Scenedesmus arcuatus</i> Lemm.	1	.....	640	.....	.....
<i>Scenedesmus quadricauda</i> (Turpin) Bréb.	2	395	139,986	277,750	.....
	3	.....	26,275,150	.....	.....
<i>Coelastrum microporum</i> Næg.*	1	386	.....	.....	.....
<i>Coelastrum reticulatum</i> (Dangeard) Senn.*	2	.....	19,200	.....	.....
<i>Pediastrum duplex</i> Meyen.	1	.....	660,000	.....	.....
<i>Pediastrum tetras</i> (Ehr.) Ralfs.	2	.....	320	320	.....
	3	380	.....	.....	.....

Organisms	Pond	July 20, 1928	Sept. 3, 1928	Dec. 1, 1928	Apr. 3, 1929
<i>Clostrix</i> sp.*	3	.....	.....	4,600	.....
<i>Spirogyra</i> spp.*	{ 1 3	 520	.....	270	.....
	{ 3	.....	.....	230	.....
<i>Netrium digitus</i> (Ehr.) Itz. & Roth.	{ 1 3	 260	 350	270	3,300
	{ 3	.....	.....	1,380	8,000
	{ 1	.....	..... 350	.....	1,320
<i>Closterium moniliferum</i> (Bory) Ehr.	{ 2 3	.....	.....	.....	660
	{ 3	.....	..... 2,400	 1,380	.....
<i>Closterium venus</i> Kütz	3	 193	.....	.....	.....
	{ 1	 260	 360	.....	3,300
<i>Closterium acerosum</i> (Schränk) Ehr.	{ 2 3	.....	..... 960	 320	.....
	{ 3	.....	..... 1,200	 9,200	4,000
<i>Closterium gracile</i> var. <i>elongatum</i> W. & G. S. West.	2	.....	.....	..... 320	.....
<i>Closterium strigosum</i> Ehr.	{ 1 2	.....	.....	..... 10,000	.....
	{ 2	.....	.....	..... 320	.....
<i>Closterium subtruncatum</i> W. & G. S. West.	3	.....	.....	..... 460	.....
<i>Pleurotaenium</i> sp.	{ 1 3	.....	.....	.....	1,650
	{ 3	.....	.....	.....	1,600
<i>Spondylostium planum</i> W. and G. S. West.	1	.....	.....	.....	33,000
<i>Cosmarium depressum</i> (Näg.) Lund.	3	 1,541	.....	.....	.....
<i>Cosmarium quinarium</i> Lund.	1	 260	.....	.....	.....
<i>Cosmarium botrytis</i> (Bory.) Menegh.	{ 1 3	 260	.....	.....	.....
	{ 3	.....	..... 600	.....	.....
<i>Micrasterias americana</i> (Ehr.)	1	.....	.....	.....	330
<i>Staurastrum gracile</i> Ralfs.	{ 2 3	.....	..... 191,092	.....	.....
	{ 3	 775	.....	.....	400
<i>Staurastrum cuspidatum</i> Breb.	3	.....	.....	..... 230	.....
PROTOZOA					
<i>Arcella vulgaris</i> Ehr.	{ 1 3	 544,280	.....	.....	.....
	{ 3	.....	.....	..... 230	.....
<i>Difflugia urceolata</i> Carter.	{ 1 3	 780	.....	.....	.....
	{ 3	 1,158	 46,662	.....	.....

<i>Diffugia lobostoma</i> Leidy.....	{ 1	186,656	33,000	3,000	68,000
	{ 2	666,690	95,460	44,440	33,800
<i>Diffugia globulosa</i> Duj.....	{ 3	135,035	.....	27,750	96,663
<i>Diffugia acuminata</i> Ehr.....	{ 1	71,104	.....	.....	.....
	{ 3	.....	.....	240	.....
<i>Euglena viridis</i> Ehr.....	{ 1	.....	660,000	.....	.....
	{ 2	11,110,000	955,460	44,440	.....
	{ 3	.....	2,799,720	.....	.....
	{ 1	35,552	3,500	.....	.....
<i>Euglena oxyuris</i> Schwarda.....	{ 3	386	46,662	.....	36,600
<i>Euglena tripteris</i> Duj.....	{ 3	386	.....	.....	.....
<i>Euglena acus</i> Ehr.....	{ 1	.....	4,800	.....	.....
	{ 2	35,552	33,000	.....	25,000
<i>Phacus longicaudus</i> (Ehr.).....	{ 2	133,330	95,546	10,000	16,665
	{ 3	386	.....	.....	73,100
	{ 2	33,566	66,000	.....	.....
<i>Phacus acuminata</i> Stokes.....	{ 3	380	46,662	.....	.....
	{ 1	711,040	16,500,000	8,000,000	1,350,000
<i>Trachelomonas volvocina</i> Ehr.....	{ 2	26,664,000	477,730,000	88,880,000	19,998,000
	{ 3	38,610	74,639,200	7,443,50	3,666,300
	{ 1	1,066,560	330,000	.....	.....
<i>Trachelomonas similis</i> Stokes.....	{ 2	6,660,000	1,433,190	.....	.....
	{ 3	772	.....	.....	.....
	{ 2	.....	3,821,840	.....	.....
<i>Trachelomonas magdaleniana</i> Defl.....	{ 3	193	.....	.....	.....
<i>Trachelomonas tambowitica</i> Swir.....	{ 2	.....	2,388,650	.....	.....
<i>Trachelomonas armata</i> (Ehr.).....	{ 1	.....	1,650,000	.....	.....
	{ 3	.....	2,366,300	.....	.....
<i>Trachelomonas hispida</i> (Perty).....	{ 2	76,670,000	34,996,500	27,750	.....
	{ 3	19,444	238,865	.....	.....
<i>Trachelomonas ensifera</i> Daday.....	{ 2	.....	1,399,860	.....	.....
<i>Mallomonas producta</i> (Zach.).....	{ 3	772	.....	13,580	600,000

Organisms	Pond	July 20, 1928	Sept. 3, 1928	Dec. 1, 1928	Apr. 3, 1929
<i>Mallomonas caudata</i> Iwanoff.....	1 { 1 2 {	17,776	330,000 12,800	520,000	520,000 300,000
<i>Dinobryon sertularia</i> Ehr.....	3 { 1 3 {	366,795	 33,000	1,888,750 100,000	 27,000
<i>Chlamydomonas</i> spp.	3 { 1 3 {	3,861 33,552,000	22,333,100	11,110,000	966,630
<i>Pandorina morum</i> Bory*.....	3 { 1 3 {	..... .....	1,866,480 1,600	..... .....	..... 18,000
<i>Eudorina elegans</i> Ehr.*.....	1 { 1 2 {	35,552 22,220	 953,460	..... .....	..... 1,320
<i>Pleodorina californica</i> Shaw*.....	1 { 1 2 {	35,552 88,880	 143,319	..... .....	12,000
<i>Pleodorina illinoisensis</i> Kofoid*.....	2 { 1 2 {	72,440 22,220	66,000	2,000	14,000
<i>Ceratium hirundinella</i> (O. F. M.)*.....	2 { 1 3 {	5,792 1,422,080	477,730 933,240	..... .....	..... 366,630
<i>Peridinium cinctum</i> O. F. M.....	1 { 1 2 {	..... .....	1,980,000 1,433,190	..... .....	18,200 33,300
<i>Strombidium</i> sp.	3 { 1 3 {	82,625	46,662,000	555,500	1,866,530
<i>Codonella cratera</i> (Leidy).....	2 { 1 3 {	888,800 782	95,546 933,240	1,800,000	710,000 66,600
ROTATORIA					
<i>Rotaria neptunia</i> (Ehr.).....	1 { 1 2 {	..... .....	..... .....	..... .....	660 330
<i>Conochilus hippocrepis</i> Schark.....	1 { 1 2 {	260	 1,350	..... .....	..... .....
<i>Conochiloides dossuarius</i> (Hudson).....	2 { 1 3 {	3,100 190	1,280 .....	..... .....	..... .....
<i>Asplanchna sieboldii</i> (Leydig).....	1 { 1 2 {	780	 9,600	270 144,000	 412,500
	3 {	.....	.....	1,840	800

<i>Filinia longiseta</i> (Ehr.)	{ 1 2 3 }	6,500 9,300 15,444	1,400 ..... .....	..... ..... .....	660 400
<i>Polyarthra trigla</i> Ehr.	{ 1 2 3 }	15,600 15,500 7,822	35,000 48,000 3,600	18,900 76,800 27,600	165,000 165,000 260,000
<i>Diurella tigris</i> (O. F. M.)	{ 1 2 3 }	..... ..... .....	..... ..... .....	..... ..... 230	..... ..... .....
<i>Diurella stylata</i> Eysterth.	{ 1 2 3 }	..... ..... .....	350 2,400 .....	..... ..... .....	..... ..... .....
<i>Brachionus patulus</i> O. F. M.	{ 1 2 3 }	18,200	 25,600 1,200	 260	..... ..... .....
<i>Trichocerca multierinis</i> (Kellicott)	{ 1 2 3 }	386 520	3,600 3,200 48,000	2,700 19,200 8,050	 400
<i>Trichocerca pusilla</i> (Jennings)	{ 1 2 3 }	46,432 386 2,600	 960	..... ..... .....	..... ..... .....
<i>Euchlanis deflexa</i> Gosse	{ 1 2 3 }	21,700 770	 320 .....	..... ..... .....	..... ..... 400
<i>Lecane unguolata</i> (Gosse)	{ 1 2 3 }	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....
<i>Lecane ohioensis</i> (Herrick)	{ 1 2 3 }	350	600 ..... .....	..... ..... .....	..... ..... .....
<i>Lepadella acuminata</i> (Ehr.)	{ 1 2 3 }	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....
<i>Monostyla lunaris</i> (Ehr.)	{ 1 2 3 }	350 ..... .....	..... ..... .....	320	 400
<i>Monostyla bulla</i> Gosse	{ 1 2 3 }	..... ..... .....	1,280 600 1,600	..... ..... .....	..... ..... .....
<i>Monostyla quadridentata</i> Ehr.	{ 1 2 3 }	..... ..... .....	600 ..... .....	..... ..... .....	..... ..... .....
<i>Testudinella patina</i> (Hermann)	{ 1 2 3 }	3,861 ..... .....	..... ..... .....	..... ..... .....	..... ..... .....
<i>Pompholyx complanata</i> Gosse	{ 1 2 3 }	700 386 .....	..... ..... .....	..... ..... .....	..... ..... .....

Organisms	Pond	July 20, 1928	Sept. 3, 1928	Dec. 1, 1928	Apr. 3, 1929
<i>Brachionus calyciflorus</i> Pallas.....	2	.....	6,400	.....	.....
<i>Brachionus angularis</i> Gosse.....	{ 1	260	.....	.....	.....
	{ 3	11,583	2,400	.....	.....
<i>Schizocerca diversicornis</i> Daday.....	1	.....	700	.....	.....
	2	6,200	22,400	.....	.....
	1	5,200	3,500	10,800	247,500
<i>Keratella cochlearis</i> (Gosse).....	2	15,500	3,200	6,400	132,000
	3	193,050	150,000	138,000	160,000
<i>Notholca longispina</i> (Kellicott).....	{ 1	.....	700	810	660
	2	.....	320	320	19,800
<i>Pedalia mira</i> Hudson.....	{ 1	260	3,500	.....	.....
	2	.....	12,800	.....	.....
	3	.....	1,200	.....	.....
CLADOCERA					
<i>Diaphanosoma brachyurum</i> (Léveillé).....	{ 1	31,200	1,750	.....	.....
	2	3,100	1,920	.....	660
<i>Daphnia longispina</i> (O. F. M.).....	{ 1	.....	.....	1,920	1,650
	3	.....	.....	1,380	8,000
<i>Scapholeberis mucronata</i> (O. F. M.).....	3	.....	600	.....	.....
<i>Coriodaphnia lacustris</i> Birge.....	{ 1	15,600	1,050	.....	.....
	2	37,200	.....	.....	.....
	3	78,220	1,200	.....	.....
<i>Moina affinis</i> Birge.....	2	6,200	640	.....	.....
<i>Bosmina longirostris</i> (O. F. M.).....	{ 1	39,000	10,500	8,100	26,400
	2	1,550	19,200	320,000	33,000
	3	11,583	60,000	55,200	320,000
<i>Bosmina obtusirostris</i> Sars.....	3	.....	.....	1,150	.....
<i>Alona</i> sp.	{ 1	260	.....	.....	.....
	2	310	.....	.....	.....
	3	1,930	.....	.....	.....
<i>Pleuroxus hamulatus</i> Birge.....	3	.....	.....	460	.....

PLANKTON OF SINK HOLE PONDS

467

Pleuroxus trigonella (O. F. M.).....	2	.....	.....	160	.....
Pleuroxus sp.	3	600	.....	.....	.....
Chydorus sphaericus (O. F. M.).....	{ 2	9,300	.....	.....	.....
	{ 3	1,544	.....	2,300	.....
COPEPODA					
Diaptomus mississippiensis Marsh.....	{ 1	2,600	.....	4,050	39,600
	{ 2	.....	.....	.....	9,900
	{ 3	.....	.....	.....	400
Cyclops viridis Jurine.....	{ 1	31,200	17,500	1,350	660
	{ 2	96,100	67,200	400,000	6,600
	{ 3	386,100	24,000	.....	200,000
Cyclops bicuspidatus Claus.....	{ 1	.....	.....	.....	5,000
	{ 2	.....	.....	.....	82,500
	{ 3	775	.....	.....	.....
Cyclops leuckarti Claus.....	{ 1	.....	.....	24,300	.....
	{ 3	190	.....	177,500	.....
	{ 1	312,000	51,500	5,400	132,000
Immature copepods	{ 2	170,500	112,000	176,000	99,000
	{ 3	23,160	3,000	230,000	400,000
INSECTA					
Corethra larvae	{ 1	260			
	{ 2	310			
OSTRACODA					
Ostracods	2			640	

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BY

SAMUEL EDDY



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THE PLANKTON OF THE SANGAMON RIVER IN THE SUMMER OF 1929

SAMUEL EDDY

The Sangamon River, a small river in the central part of Illinois, has special interest to students of aquatic biology because it exhibits in a remarkable way the effects of the installation of a sewage treatment plant in alleviating pollution and at the same time the effects of the erection of a dam to impound water for municipal and industrial uses. The present study is an attempt to determine to what extent these effects are reflected by changes in the abundance of certain kinds of microscopic organisms, collectively called plankton, which live suspended in the water. As is well known, some kinds of plankton organisms, if present in sufficient numbers in reservoirs, may give disagreeable flavors to the water; other kinds may aid in the natural purification of polluted waters; and in streams and lakes generally plankton plays a rôle of more or less importance as food for larger organisms, including fishes. In our larger streams, such as the Rock River and the Illinois River, the plankton is a very important factor in fish production. In the Kaskaskia River, as an example of our smaller streams, the plankton is so scanty that it can have very little importance. The Sangamon River illustrates an intermediate stage in which the plankton is abundant enough to enter into the food chains of fishes to some extent but does not result in a yield of fishes appreciably greater than in the Kaskaskia. The writer's observations of plankton development in the upper part of the Sangamon from 1923 to 1929 were included in a general study on "Fresh-water Plankton Communities," submitted as a thesis in the Graduate School of the University of Illinois but not yet published. Further collections, made during the summer of 1929, showing the variety and abundance of organisms present at selected stations along the lower part of the river as well as the upper part, are reported in this paper.

The Sangamon River rises in McLean County and at first flows eastward into the northwestern part of Champaign County, where it turns southward and passes the villages of Foosland, Fisher, and Mahomet. It then flows in a general southwestward direction across

Piatt County, passing Monticello, and across Macon County, passing Decatur. In Sangamon County, it receives its first large tributary, the South Fork, and passes Riverton and Springfield. It flows northward across Menard County, passing Petersburg. At its junction with Salt Creek it turns westward. It continues in a generally westward direction, forming the boundary between Mason County and Cass County, passing the village of Chandlerville, and finally emptying into the Illinois River about ten miles above Beardstown.

The length of the river is about 237 miles. The distance from the source to Decatur is about 103 miles, from Decatur to Springfield about 59 miles, and from Springfield to the mouth about 75 miles. The total drainage area is about 5,390 square miles, of which 1,910 square miles belong to Salt Creek, and 846 square miles belong to South Fork.

The current of the river at normal levels is never very great, since it flows through glacial till and occupies a well-worn valley. The river falls 120 feet in the first 10 miles and 300 feet in the balance of its course, or less than 2 feet per mile. The fall is far from regular, however, and there are many stretches where the gradient is very slight. The bottom is usually sand or fine silt, the latter predominating over most of the river.

Previous to 1923, no obstructions were encountered in the upper course of the river except several small ruined mill-dams. At Decatur a small dam raised the water level a few feet and held back a small supply for municipal purposes. Below this dam the city of Decatur discharged all its sewage, which usually was greater in volume than the water flowing over the dam. During times of low water, the sewage constituted the entire flow of the river below the dam, as all of the water above the dam was then diverted through the city water supply system. As a result of the pollution, the river below Decatur was devoid of normal aquatic life. Jewell (1920) reported no living organisms immediately below Decatur except those accustomed to conditions of pollution. Thirty miles below Decatur conditions were found to be improving, but even at Springfield, almost 60 miles downstream, the normal life was not completely restored. The writer was well acquainted with the river previous to 1920 and clearly remembers the extreme condition of pollution existing for at least 20 miles below Decatur. The bottom was covered with a thick layer of foul sludge, and the opaque water, which varied in color from inky black to milky white, depending on the season, contained large quantities of floating mouldy wastes.

At Springfield a second dam has obstructed the river for many years, raising the level of the water about six feet and forming a narrow pool that extends upstream several miles. Pollution below Spring-

field has been largely eliminated since the city's sewage treatment plant was put into operation, July 10, 1929. The wastes from Petersburg and Chandlerville are not sufficient to pollute the river to an appreciable extent.

In 1923 the city of Decatur, in order to increase its water supply, completed a large dam across the river just above the site of the old one, creating a lake one-half mile wide and 12 miles long. Later, in 1924, a sewage disposal plant was put into operation, handling one-third of the city wastes, and in 1928 the plant was enlarged to accommodate all the wastes. This relieved the extreme condition of pollution. The dredging of a new channel from Harristown for 20 miles downstream has aided by furnishing a new bed, free from the accumulated bottom sludge. These changes have resulted in a fairly clean stream, flowing through a lake-like reservoir in its upper region.

In the writer's previous study of the plankton of the upper river from 1923 to 1928, inclusive, weekly or semi-monthly collections were made from the river at Decatur and above. Very little plankton was found above Lake Decatur in those years. At Mahomet, about 50 miles from the source, no plankton forms occurred, though bottom organisms, especially diatoms and protozoans, occasionally appeared in the collections. The same was true at Monticello during the greater part of the year, but in mid-summer or early autumn, when the water was low, a scanty population of plankton organisms was found there. This was the first point in the course of the stream where plankton ever appeared. At Rhea's Bridge on the upper end of Lake Decatur, plankton was present in the water during most of the year but was never as abundant as at Lost Bridge, one mile above the dam, where many plankton species were abundant from March until December. During January and February the plankton of the lake was scanty and consisted chiefly of protozoans.

In 1929, trips were made in June, July, and September, for the purpose of collecting samples at intervals of about 20 miles over the entire river. The collections were made from bridges at or near Mahomet, Monticello, Lake Decatur, Harristown, Illiopolis, Riverton, Springfield, Petersburg, and Chandlerville. The method was to dip the water from mid-channel by lowering a ten-liter bucket on a rope. No stratification of plankton was noticed except at Lake Decatur, where the current was negligible and the plankton was much heavier near the surface. The principal collecting station on the lake was at Lost Bridge, and at this station a series of collections was made from bottom to surface and averaged. Each set of collections made at the other stations consisted of a 100-liter silk-net collection and a one-liter

collection which was preserved with formalin and allowed to settle and then decanted in order to obtain the nanoplankton. The organisms were counted by the usual method in a Sedgwick-Rafter slide. All data were computed per cubic meter. The volume of the plankton in the silk-net collections was obtained by centrifuging for 3 minutes at 2000 revolutions per minute. The volume of the decanted plankton was not determined because of the large amount of silt present.

At the times of collecting, the river was 1-2 feet deep and 25-40 feet wide at Mahomet, the uppermost station, and 8-10 feet deep and 200-210 feet wide at Chandlerville, the lowermost station. The deepest portion from which collections were made was in Lake Decatur where the depth in the channel ranged from 10 to 18 feet. Below Decatur the river was quite shallow. It was 2-4 feet deep and 60-75 feet wide at the Harristown and Illiopolis bridges. At Riverton, after the union with the South Fork, the river was 4-6 feet deep and 100-114 feet wide. At the bridge north of Springfield the water (backed up by the dam) was 5-7 feet deep and 100-110 feet wide. At Petersburg the river was 100-150 feet wide and 7-10 feet deep in mid-channel.

The current, which was moderate at most places, was very slow in some stretches of the river and somewhat swifter in others with a greater fall. At Mahomet and Monticello, the current averaged about one-half mile per hour during the summer. In the main part of Lake Decatur no current could be detected. At Harristown and Illiopolis the current averaged about one mile per hour; at Riverton one-half mile per hour; and at Springfield just above the dam it was too slow to estimate. At Petersburg and Chandlerville it averaged a little more than one-half mile per hour.

The river level was slightly above normal when the plankton collections were made in June and July. The readings of the gage at the Decatur sewage disposal plant averaged 587.3 feet for June 25-27 and 587.6 feet for July 26-28. April and May were the highest months for the year 1929, the gage at the disposal plant reaching a maximum of 593.5 feet in those months. The lowest stage for the year was in September, although the gage readings on the dates of collections, September 10-12, averaging 584.0 feet, were not the lowest of the month. Thus the river was about $3\frac{1}{2}$ feet lower in September than it was when the June and July collections were made. The Decatur lake, however, did not fluctuate much, as the gage reading above the dam was 610.25 in June and July and 609.95 in September.

The temperature of the water at the time of collecting was about what would be expected under normal summer conditions. In June it ranged from 21° to 25°C. and in July from 25° to 28°C. No tem-

perature data were obtained on the September trip, as the thermometer was broken in the field.

Hydrogen ion determinations were made at all stations and were found to run consistently about pH 7.6. This seemed normal for the river, as the readings agreed with those obtained by the writer in previous observations. On the upper river from 1923 to 1929, the readings in summer always ranged around pH 7.6, dropping to pH 7.0 or lower in winter.

Determinations of dissolved oxygen in the water at each station on the June trip were as follows: Mahomet 4.75 cc. per liter, Monticello 4.06, Decatur 4.62, Harristown 4.06, Illiopolis 4.62, Riverton 4.25, Petersburg 4.25, and Chandlerville 6.47. No determinations can be given for Springfield, as the June collections and data from that station were accidentally lost. There was only a slight fluctuation in the amount of dissolved oxygen in the water at the various stations. At all points examined, the supply seemed sufficient for the support of abundant aquatic life.

A summary of the plankton collections is given in Table I, and the constituent organisms are listed in Tables II, III, and IV.

The general taxonomic composition of the plankton found in the river below Monticello was the same as that observed in most shallow lakes and larger streams of North America. Certain typical forms were conspicuous in their proper seasons, namely: two protozoans, *Codonella cratera* and *Ceratium hirundinella*; rotifers of the genera *Brachionus*, *Synchaeta*, *Polyarthra*, and *Keratella*; various cladocerans, particularly *Moina affinis*, *Daphnia longispina*, and *Bosmina longirostris*; and two copepods, *Diaptomus siciloides* and *Cyclops bicuspidatus*. A few bottom organisms, usually diatoms and protozoans, were often conspicuous in the plankton collections from the shallow portions of the river where the current could easily sweep them up from the bottom. They did not often appear in the collections from Lake Decatur but were quite common in the collections from the other stations, especially at Monticello, Harristown and Illiopolis.

The collections made in June showed no plankton at Mahomet and only a very scanty plankton at Monticello. The first heavy plankton occurred at Lost Bridge in Lake Decatur. Both the volume of the plankton and the number of species in the collections decreased downstream as far as Petersburg and Chandlerville, where the number of species increased slightly, though the volume of the plankton continued to decrease. Of the 50 species observed in the collections from the entire river in June, 36 appeared in Lake Decatur and 12 appeared farther downstream in relatively small numbers. Evidently a large

amount of the downstream plankton owed its origin to the increase in Lake Decatur. Characteristic species which were most conspicuous in Lake Decatur and showed a decrease downstream were *Diffugia lobostoma*, *Codonella cratera*, *Brachionus angularis*, *Polyarthra trigla*, *Keratella cochlearis*, *Moina affinis*, *Daphnia longispina*, *Bosmina longirostris*, *Cyclops bicuspidatus*, and *Lysigonium (Melosira) granulatum*. Several other members of the plankton conspicuous in the lake did not appear at all below. The flagellates, *Trachelomonas volvocina* and *Euglena viridis*, decreased downstream to Petersburg and then started to increase. The only form that showed a decided increase below the lake was one of the algae, *Actinastrum hantzschii*.

The collections made in July showed that the plankton then had a distribution very similar to that of the preceding month. At Mahomet there was no plankton at all, and at Monticello it was very scanty. Of the 58 species found in the July collections, 47 first became abundant in Lake Decatur. Only 8 species occurred downstream which did not occur in the lake, and these were usually rare or inconspicuous, never forming an important part of the plankton. Many forms which were conspicuous in Lake Decatur showed a decided decrease below Decatur and apparently had their origin in the lake. Examples of these were the following: *Pandorina morum*, *Pleodorina illinoisensis*, *Codonella cratera*, *Diffugia lobostoma*, *Trachelomonas ensifera*, *Euglena viridis*, *Ceratium hirundinella*, *Eudorina elegans*, three species of the genus *Brachionus* and species of *Filinia (Triarthra)*, *Asplanchna*, *Polyarthra*, *Synhacta*, *Pedalia*, and *Trichocerca (Rattulus)*, and *Lysigonium (Melosira) granulatum*. Only a few forms which decreased below Decatur showed a slight increase at Chandlerville. A peculiar feature was an increase in the number of *Cyclops bicuspidatus*, *Keratella cochlearis*, *Diaphanosoma brachyurum*, and *Brachionus angularis* at Harristown and Illiopolis. In general, the July plankton showed a decided decrease below Decatur. Just as in June, the lake apparently was acting as a reservoir, developing an abundant plankton which was then carried downstream and gradually thinned out in the lower river as the water was diluted by tributaries.

The September collections were made under somewhat different conditions from those in June and July, for the level of Lake Decatur was slightly below the crest of the dam, so that little or no water passed over, and the chief source of the water in the river below Decatur was the effluent from the city's sewage disposal plant. The current in the river was not as swift as at higher river levels, and under such conditions the larger tributaries, particularly the South Fork and Salt Creek, might be expected to add a small amount of plankton.

While there still were no plankton organisms found at Mahomet, the plankton was more abundant at Monticello than previously. In Lake Decatur the collections were found to have a somewhat smaller volume and to include fewer species than previously. Downstream from the lake, however, many species, apparently originating in it, especially protozoans and algae, showed a steady increase in abundance; and several species additional to the lake list make their first appearance just below Decatur. Many conspicuous members of the plankton, particularly rotifers, appeared first at Riverton after the union with the South Fork and were abundant downstream from there. A decided increase in both abundance and species was noted at Springfield, which may in part be due to slack water above the dam. A further increase at Petersburg indicated that other conditions were favorable for greater plankton production.

Only a few species abundant in Lake Decatur showed a tendency to decrease rather than increase downstream. These were *Diffugia lobostoma*, *Codonella cratera*, *Brachionus angularis*, *Keratella cochlearis*, and some of the cladocerans and copepods. Of the 66 species found in the September collections, only 25 occurred in Lake Decatur, and 33 species occurred in the downstream collections which did not appear in the lake. Many of the latter showed a tendency to increase downstream. The increase was marked at Springfield and Petersburg, indicating that the lower river was maintaining a plankton population due in part to the low water stage and the reduction of the current. Such conditions in the river approach lake conditions, the waters remaining longer in the pool-like stretches. Since no water was then coming directly downstream from the lake, all the water in the river was effluent from the sewage disposal plant. Agersborg (1929) found this effluent to be teeming with annelids, rotifers, copepods, protozoans and algae, and states that these are organisms such as live in small ponds, though failing to mention any species which are typical of either clean-water or sewage plankton. It is doubtful if many, or any at all, of the lake forms survive passage through the sewage disposal plant, comprising as it does both sand filters, tanks and Dorr separators; and still more doubtful that there is any important development of additional plankton species until after the passage through the plant is completed.

Sphaerotilus natans, although very abundant in the sewage disposal plant, did not appear at any time in the collections. It is probable that the origin of many of the downstream plankton species at this period was in the quieter stretches of the river, which were seeded by the plankton originating in the lake at times when the water was passing over the dam.

The question often arises whether the plankton in a given part of a stream is developed there under local conditions or whether it is carried down from upstream. This survey indicates that, at times, part of the plankton, at least, is carried downstream. Wiebe (1928) and the Minnesota State Board of Health (1928) show that clean plankton from upstream is carried through polluted areas in the Mississippi below Minneapolis and St. Paul. In the Sangamon the downstream decrease observed in June and July may be due partly to the fact that local development was not sufficient to counterbalance the dilution from tributaries. In September, when the low stage of the water cut off the direct supply from the lake, local conditions downstream became more favorable for the development of plankton. When the current becomes very slow, the development of plankton becomes local and is governed by local conditions. If the current averaged one-half mile per hour, the time required for water to flow from the source to the mouth would be about 20 days. However, at normal stages the river has many pool-like stretches which retard part of the water, and rough estimates of the period of detention in the lake at Decatur range from two weeks to two months, depending on the river level. Thus the water remains in the lake at least twice as long as in the rest of the river. The water and the plankton it bears as it flows over the dam at Decatur will ordinarily be in the neighborhood of Chandlerville about a week later. In this way, at normal levels, there is a continual stream of water carrying plankton from the lake and passing downstream. Even though the downstream conditions are not favorable for plankton development, it seems possible for the water to retain part of the original plankton load for a week or more, so that a series of collections made at various points in the lower course of the river do not represent the development of plankton at each point but give glimpses of various stages of senescence as the plankton moves away from its source. It may be possible that the plankton observed downstream in September had originated from the lake when the water was still flowing over the dam, and that it was still progressing downstream. This, however, would hardly explain the origin of the plankton observed in the river immediately below Decatur.

No evidence of the former pollution was observed in the plankton of the Sangamon River. No pollutional organisms were found at Haristown, about eight miles below Decatur, where Jewell ten years earlier had found the plankton to be characterized by *Sphaerotilus natans*, nematodes, ciliates, and creeping rotifers, with desmids and phytoflagellates common when the water was high. In this area in 1929 the plankton was typical of clean water and was characterized by *Codonella cra-*

tera, *Polyarthra trigla*, rotifers of the genus *Brachionus*, *Cyclop's bicuspidatus*, *cladocerans*, and *Lysigonium (Melosira) granulatum*. Jewell found the dissolved oxygen usually low in that part of the river, especially during periods of low water. The determinations of dissolved oxygen made in 1929 showed an abundant supply. The sludge which was formerly so abundant had nearly disappeared, the water was clear, and a number of fishes were observed.

Very little is known regarding the former condition of the plankton below the polluted part of the river. Jewell's studies in 1918-1919, which extended only as far as Springfield, showed that the influence of pollution had partly ceased there and that a few typical clean-water plankton organisms were present in the river at that point. The abundant clean-water plankton now found in that part of the stream, including many more species than were reported by Jewell, indicates that the plankton population in the lower river is much greater than formerly, and this is due, no doubt, to the creation of the lake at Decatur and to the removal of the pollution barrier.

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TABLE I.
SUMMARY OF PLANKTON COLLECTIONS, SANGAMON RIVER, 1929.

Station	Volume (cc. per cubic meter)			Number of species represented		
	June 25-27	July 26-28	Sept. 10-12	June 25-27	July 26-28	Sept. 10-12
Monticello.....	.08	.08	.05	9	8	16
Lake Decatur.....	15.20	9.50	9.60	36	47	25
Harristown.....	6.00	8.00	10.00	22	34	27
Illiopoli.....	9.00	8.00	8.40	23	31	26
Riverton.....	3.00	3.90	3.60	17	35	35
Springfield.....	....	.80	12.60	..	28	36
Petersburg.....	2.20	.40	17.00	22	22	39
Chandlerville.....	.50	.30	6.00	24	22	30

TABLE II.
NUMBERS OF PLANKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, JUNE 25-27, 1929.
Italics indicate decantation collections.

Organisms	Monticello	Lake Decatur	Harristown	Illiopis	Riverton	Petersburg	Chandler-ville
PROTOZOA							
<i>Difflugia lobostoma</i> Leidy.....	86,820	100,000	80,658	60,000	25,000	22,000	20,000
<i>Trachelomonas ensifera</i> Daday.....	43,000						888,000
<i>Euglena</i> sp.	40,000	50,000					660,000
<i>Codonella cratera</i> (Leidy).....	42,000	6,000,000	288,860	280,000	290,000	410,000	60,000
<i>Tintinnidium fluviatile</i> Stein.....		750,000			14,000	11,500	220,000
<i>Phacus longicauda</i> (Ehr.).....		500		580		400	
<i>Ceratium hirundinella</i> O.F.M.....		1,000					2,500
<i>Euglena oxyuris</i> Schmarda.....		50,000		1,100	800		
<i>Trachelomonas volvocina</i> Ehr.....		50,000	28,850	27,000	28,000	20,000	84,000
<i>Euglena viridis</i> Ehr.....		100,000	28,000	55,000	16,000	22,200	110,000
<i>Dinobryon sertularia</i> Ehr.....		15,000	15,000	11,600	1,000	1,600	250
<i>Centropyxis aculeata</i> Stein.....			2,000	2,200	550	800	
<i>Arcella vulgaris</i> Ehr.....			25,000	28,000			
<i>Trachelomonas hispida</i> (Perty).....				25,000			
<i>Pleodorina illinoisensis</i> Kofoid.....					510	2,400	250
<i>Eudorina elegans</i> Ehr.....							500
<i>Euglena acus</i> Ehr.....							120
<i>Pandorina morum</i> Bory.....							110,000
ROTATORIA							
<i>Filinia longiseti</i> (Ehr.).....	240	10,000					
<i>Brachionus angularis</i> Gosse.....	200	10,000	500	580	500	700	2,500
<i>Brachionus capsuliflorus</i> Pallas.....		3,000					
<i>Brachionus calyciflorus</i> Pallas.....		1,500					
<i>Brachionus budapestinensis</i> Daday.....		15,000					
<i>Synchaeta pectinata</i> Ehr.....		500					
<i>Brachionus patulus</i> O.F.M.....		500					500
<i>Asplanchna</i> sp.		15,000					
<i>Polysartha trigla</i> Ehr.....		90,000	15,000	8,700	1,100	12,000	1,000

TABLE II—Concluded.
NUMBERS OF PLANKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, JUNE 25-27, 1929.
Italics indicate decantation collections.

Organisms	Monticello	Lake Decatur	Harristown	Illioopolis	Riverton	Petersburg	Chandler-ville
Keratella cochlearis (Gosse).....		50,000	2,500	1,200	1,080	8,000	3,700
Lecane spinifera (Western).....		1,000					250
Rotaria neptunia (Ehr.).....		250					
Pedalis mira (Hudson).....			1,000				
CLADOCERA							
Moina affinis Birge.....		30,000	500				2,500
Diaphanosoma brachyurum* (Liéven)...		2,500	15,000	2,000			
Daphnia longispina (O.F.M.).....		15,000	1,000	1,100			
Bosmina longirostris (O.F.M.).....		10,000	1,000	5,800			
Scapholeberis mucronata (O.F.M.).....		500					
Chydorus sphaericus (O.F.M.).....		500					
COPEPODA							
Cyclops bicuspidatus Claus.....		75,000	25,000	47,200	540		1,000
Cyclops viridis Jurine.....	240					12,000	
Immature copepods.....		150,000	190,000	92,000	2,700		5,000
ALGAE							
Undetermined diatoms.....	1,736,460	2,500,000	2,880,000	1,738,000	1,300,000	1,200,000	1,110,000
Gyrodinium spp.	43,411	50,000	25,000				
Lysigonium granulatum (Ehr.).....		25,000,000	8,663,800	2,800,000	1,450,000	1,334,000	2,220,000
Closterium acutum (Lyngb.).....		50,000					22,000
Coelastrum microporum (Nägel).....		40,000					
Ankistrodesmus falcatus (Corda).....		60,000					
Actinastrum hantzschii Lager.....		35,000	288,800	884,000	56,000		21,200
Scenedesmus quadricauda (Turp.).....			28,000	58,000		22,000	
Pediastrum duplex Meyen.....			1,000	5,800	5,400	2,000	
Scenedesmus dimorphus (Turp.).....				26,000	28,000	800	
Synedra tenuissima Kütz.....						2,400	

TABLE III.

NUMBERS OF PLANKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, JULY 26-28, 1929.

Italics indicate decantation collections.

Organisms	Monti- cello	Lake Decatur	Harris- town	Illio- polis	Riverton	Spring- field	Peters- burg	Chandler- ville
PROTOZOA								
<i>Diffugia acuminata</i> Ehr.....	15,000	400,000			187,200	800	25,500	69,600
<i>Pandorina morum</i> Bory.....		75,000			220	24,000		
<i>Platydotina caudata</i> Kofoid.....		125,000	660		880			
<i>Pleodorina illinoisensis</i> Kofoid.....		1,600,000	490,000	966,000	1,218,000	1,170,000	357,000	70,000
<i>Codonella cratera</i> (Leidy).....		6,50,000	98,000	644,000	624,000	26,000	51,000	1,260
<i>Diffugia lobostoma</i> Leidy.....		220,000		32,200	62,000	73,500	12,000	70,000
<i>Trachelomonas ensifera</i> Daday.....		7,500			30,900			
<i>Trachelomonas hispida</i> (Perty).....		250					220	420
<i>Phacus longicauda</i> (Ehr.).....		210,000	95,600		125,000	98,900	76,500	139,500
<i>Euglena viridis</i> Ehr.....		750						46,500
<i>Euglena acutissima</i> Lemm.....		8,700	650	7,100	1,320			2,520
<i>Ceratium hirundinella</i> O.F.M.....		250						
<i>Phacus pleuronectes</i> (O.F.M.).....		120,000	25,500	30,000	60,000	122,500	51,000	149,000
<i>Tintinnidium fluviatile</i> Stein.....		410,000		32,000	31,000	12,000		70,000
<i>Eudorina elegans</i> Ehr.....		21,000		32,000	30,000			11,000
<i>Euglena oxyuris</i> Schmarda.....		12,500	19,800	5,400				
<i>Dinobryon sertularia</i> Ehr.....		30,000	49,000		62,000	215,000	76,500	
<i>Trachelomonas volvocina</i> Ehr.....			600	2,160	850	400	440	
<i>Centropyxis aculeata</i> Stein.....				4,320				
<i>Arcella vulgaris</i> Ehr.....								
<i>Gonium pectorate</i> O.F.M.....					220			

TABLE III—Continued.

NUMBERS OF PLANKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, JULY 26-28, 1929.

Italics indicate decantation collections.

Organisms	Monti- cello	Lake Decatur	Harris- town	Illioiopolis	Riverton	Spring- field	Peters- burg	Chandler- ville
ROTATORIA								
<i>Brachionus calyciflorus</i> Pallas.....	260	112,500	28,400	48,600	400			
<i>Brachionus capsuliflorus</i> Pallas.....		5,000	650	540	1,200	400	220	
<i>Brachionus budapestinensis</i> Daday.....		187,500	6,600	32,400	890	400		
<i>Brachionus angularis</i> Gosse.....		10,000	13,200	21,600		1,600	440	
<i>Trichocerca pusilla</i> (Jennings).....		5,000	660	550				
<i>Filinia longiseti</i> (Ehr.).....		62,500	9,900	37,800	13,200	6,000		1,260
<i>Trichocerca gracilis</i> (Gosse).....		12,500		5,400	1,300	800	400	
<i>Asplanchna</i> sp.		70,000	1,980	16,200	880	400		
<i>Polyarthra trigla</i> Ehr.....		75,000	33,000	64,800	4,400	450	1,320	1,300
<i>Keratella cochlearis</i> (Gosse).....		2,500	13,200	81,000	35,200	8,000	8,800	12,600
<i>Synchaeta pectinata</i> (Ehr.).....		225,000	2,640	2,700	2,200	2,000	450	
<i>Pedalia mira</i> (Hudson).....		87,500	27,000	43,200	1,760			
<i>Brachionus patulus</i> O.F.M.....		250		270				420
<i>Diurella stylata</i> Eyferth.....		250						
<i>Conochiloides natans</i> (Seligo).....		250		1,620				
<i>Schizocerca diversicornis</i> Daday.....								
CLADOCERA								
<i>Diaphanosoma brachyurum</i> (Lievén)...	250	9,900	2,700					
<i>Meina affinis</i> Birge.....	500	650	540					
<i>Daphnia longispina</i> (O.F.M.).....		660	540					
<i>Bosmina longirostris</i> (O.F.M.).....		650						

TABLE III—Concluded.
NUMBERS OF PLANKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, JULY 26-28, 1929.

Italics indicate decantation collections.

Organisms	Monti- cello	Lake Decatur	Harris- town	Illio- polis	Riverton	Spring- field	Peters- burg	Chandler- ville
COPEPODA								
<i>Cyclops bicuspidatus</i> Claus.....		5,500	5,200	5,400	880	800	880	3,800
<i>Diaptomus siciloides</i> Lillje.....		120	650	550	440			
Immature copepods	260	37,500	19,800	5,500	2,200	800	880	25,200
ALGAE								
Undetermined Diatoms	936,000	5,000	735,000	322,000	1,560,000	490,000	25,000	3,480,000
<i>Gyrosigma</i> sp.	15,500		980,000	1,620	450	21,500		
<i>Closterium acutum</i> (Lyngb.)	250	10,000,000	4,900,000	614,000	1,872,000	49,000	127,500	130,200
<i>Lysigonium granulatum</i> (Ehr.)		40,000			31,200	24,000		
<i>Scenedesmus quadricauda</i> (Turp.)		20,000	25,500			23,000	25,500	
<i>Scenedesmus dimorphus</i> (Turp.)		2,500			870	1,600	440	2,520
<i>Pediastrum duplex</i> Meyen.		12,500	980,000	2,160	880	2,400	880	
<i>Synedra tenuissima</i> Kütz.		240						
<i>Pediastrum simplex</i> Meyen.		20,000	21,000	32,000	30,000	24,500	26,000	70,000
<i>Actinastrum hantzschii</i> Lager.								
<i>Cocleastrum microporum</i> Nägel.		230						
<i>Surirella robusta</i> Ehr.			650		31,000			
<i>Sphinctocystis librilis</i> (Ehr.)								1,260
<i>Closterium moniliferum</i> (Bory)								1,300
<i>Aphanocapsa</i> sp.								

TABLE IV.

NUMBERS OF PLANKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, SEPTEMBER 10-12, 1929.

Italics indicate decantation collections

Organisms	Monti- cello	Lake Decatur	Harris- town	Illio- polis	Riverton	Spring- field	Peters- burg	Chandler- ville
PROTOZOA								
<i>Diffugia acuminata</i> Ehr.....	250		27,000	1620	920	500	480	5,600
<i>Endorina elegans</i> Ehr.....	250	220						
<i>Ceratium hirundinella</i> O.F.M.....	250	880						
<i>Euglena viridis</i> Ehr.....	62,000	1,222,100	1,310,000	1,400,000	97,600	1,385,000	400,000	534,000
<i>Pleodorina illinoisensis</i> Kofoed.....		200				500		
<i>Euglena oxyuris</i> Schmarda.....		60,000	30,000	35,000	24,000		160,000	
<i>Diffugia lobostoma</i> Leidy.....		288,000	32,000	12,000	25,000	28,000	20,000	
<i>Odonella cratera</i> (Leidy).....		489,000	27,000	14,000	10,000	27,000	40,000	2,800
<i>Phacus longicauda</i> (Ehr.).....		24,400	14,000	540	1,380	500	1,920	
<i>Trachelomonas hispida</i> (Perty).....		440	27,700			2,770,000	1,600,000	
<i>Chlamydomonas</i> spp.		488,840				6,925,000		
<i>Arcella vulgaris</i> Ehr.....			28,000	5,500	3,060	5,000		280
<i>Centropyxis aculeata</i> Stein.....			480	1,080				
<i>Trachelomonas volvocina</i> Ehr.....			1,668,000	1,750,000	1,220,000	48,475,000	6,400,000	2,670,000
<i>Phacus acuminata</i> Stokes.....			14,000				34,000	
<i>Trachelomonas ensifera</i> Daday.....				70,000	25,000	1,385,000	4,000,000	
<i>Phacus pleuronectes</i> (O.F.M.).....				250		500		
<i>Euglena acutissima</i> Lemm.....				70,000	20,000		80,000	
<i>Glennodinium</i> sp.					45,000	28,000	75,000	
<i>Tintinnidium fluviatile</i> Stein.....					976,000	21,940,000	4,000,000	26,700
<i>Pandorina morum</i> Bory.....					24,400		480	
<i>Gonium pectorale</i> O.F.M.....						14,000		
<i>Platydorina caudata</i> Kofoed.....							2,880	

TABLE IV—Continued.
 NUMBERS OF PLENKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, SEPTEMBER 10-12, 1929.
Italics indicate decantation collections.

Organisms	Monti- cello	Lake Decatur	Harris- town	Illioplis	Riverton	Spring- field	Peters- burg	Chandler- ville
ROTATORIA								
<i>Brachionus angularis</i> Gosse.....	250	2,640	240				960	1,400
<i>Brachionus budapestinensis</i> Daday.....	250							560
<i>Brachionus calyciflorus</i> Pallas.....	250	850			1,840	375,000	196,800	67,200
<i>Distylla spinifera</i> Western.....	250				1,600			
<i>Polyarthra trigla</i> Ehr.....	250	8,800	480		500	15,000	1,920	1,400
<i>Synchaeta pectinata</i> (Ehr.).....	250				980		9,600	
<i>Asplanchna</i> sp.	120						950	
<i>Keratella cochlearis</i> (Gosse).....		860	480		230			
<i>Brachionus capsuliflorus</i> Pallas.....				250	9,200	80,000	2,400	2,800
<i>Synchaeta stylata</i> Wierz.....					13,800	1,050,000	384,000	8,400
<i>Trichotria tetractis</i> (Ehr.).....					5,060			
<i>Diurella stylata</i> Eyferth.....						500		
<i>Trichocerca pusilla</i> (Jennings).....						5,000		
<i>Trichocerca gracilis</i> (Gosse).....						10,000		
<i>Asplanchna</i> sp.						1,000		
<i>Rotaria neptunia</i> (Ehr.).....							480	2,100
<i>Trichocerca stylata</i> (Gosse).....							450	
<i>Annureopsis fissa</i> (Gosse).....								270
CLADOCERA								
<i>Diaphanosoma brachyurum</i> (Liéven)...		450						
<i>Daphnia longispina</i> (O.F.M.).....		4,500						

TABLE IV—Concluded.
NUMBERS OF PLENKTON ORGANISMS PER CUBIC METER IN THE SANGAMON RIVER, SEPTEMBER 10-12, 1929.
Italics indicate decantation collections.

Organisms	Monti- cello	Lake Decatur	Harris- town	Illio- polis	Riverton	Spring- field	Peters- burg	Chandler- ville
COPEPODA								
<i>Diaptomus siciloides</i> Lillje.....	110	6,600	4,800	600	250			
<i>Cyclops viridis</i> Jurine.....		450						
Immature copepods		52,800	9,600	1,200	50	500	900	2,900
ALGAE								
Undetermined diatoms	3,120,000	1,222,100	55,550,000	35,000,000	3,660,000	11,980,000	10,000,000	53,400,000
<i>Gyrosigma</i> spp.	936,000		277,750	350,000	7,32,000	28,000	160,000	1,602,000
<i>Sphinctocystis</i> <i>librillis</i> (Ehr.)	15,000		960					550
<i>Schroederia</i> <i>setigera</i> (Schröder)	31,200							
<i>Cyclotella</i> spp.		2,444,200						
<i>Pediastrum</i> <i>duplex</i> Meyen		440	7,200	16,200	9,200	27,700,000		26,700,000
<i>Lysigonium</i> <i>granulatum</i> (Ehr.)		3,660,300	22,220,000	17,500,000	244,000	45,000	192,000	56,000
<i>Scenedesmus</i> <i>quadricauda</i> (Turp.)		2,200	111,100	1,050,000	122,000	1,662,000	9,600,000	1,335,000
<i>Closterium</i> <i>acutum</i> (Lyngb.)		122,000	277,750	350,000	24,000	13,600	800,000	2,136,000
<i>Selenastrum</i> <i>gracile</i> Reinsch		220						276,000
<i>Closterium</i> <i>acerosum</i> (Schrank)			960				480	
<i>Closterium</i> <i>moniliferum</i> (Bory)			480					540
<i>Ankistrodesmus</i> <i>falcatus</i> (Corda)			84,743,750	14,000,000	45,000	554,000	800,000	1,602,000
<i>Scenedesmus</i> <i>dimorphus</i> (Turp.)			53,550	35,000	46,000	210,000	800,000	560,000
<i>Synedra</i> <i>tenuissima</i> Kütz.			446,625	700,000	125,000	1,108,000	70,000	544,000
<i>Cocleastrum</i> <i>microporum</i> Nägel.				10,000	12,000	25,000	75,000	26,000
<i>Cosmarium</i> sp.				10,800	1,820			
<i>Actinastrum</i> <i>hantzschii</i> Lager.				700,000	24,000	12,465,000	3,200,000	1,835,000
<i>Microtilinum</i> <i>pustillum</i>							1,440	5600
<i>Surirella</i> <i>robusta</i> Ehr.					4,600			
<i>Pediastrum</i> <i>simplex</i> Meyen							450	

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THEODORE H. FRISON, *Chief*

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BULLETIN

Article VI.

An Experimental and Observational
Study of the Chinch Bug in Rela-
tion to Climate and Weather

BY

V. E. SHELFORD



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CONTENTS

	PAGE
Introduction	487
Equipment and operation.....	488
Length of Instars and the Life History.....	489
Methods and results.....	490
Table I. APPROXIMATELY CONSTANT TEMPERATURE.....	491
Table II. VARIABLE TEMPERATURE	495
Individual variation	497
Effect of humidity.....	498
Table III. HUMIDITY DIFFERENCES	499
Table IV. SIMULATION OF DAILY MARCH OF TEMPERATURE AND RELATIVE HUMIDITY	501
Table V. COMBINED VELOCITY VALUES	503
Table VI. LENGTH OF LIFE CYCLE.....	503
Velocity curves and charts.....	504
Table VII. CULTURAL CONDITIONS	505
Developmental totals	513
Overwintering	515
The Cultures	515
Vigor of stock.....	519
Effect of light.....	521
Abundance in Nature.....	531
History in Illinois.....	531
Weather relations	533
Conclusion	545
Bibliography	546

AN EXPERIMENTAL AND OBSERVATIONAL STUDY OF THE CHINCH BUG IN RELATION TO CLIMATE AND WEATHER

V. E. SHELFORD

INTRODUCTION

The abundance of the chinch bug (*Blissus leucopterus* Say) has long been associated with variations and peculiar distributions of rainfall and temperature in particular years or series of years. A desire for more detailed evidence from the experimental side led to this investigation. Unfortunately, however, the chinch bug is difficult to study in this way, and at the same time the task could not be made the sole or primary work of even one investigator. Accordingly, general cultures instead of close observation of individuals had to play an important rôle in the work.

The investigation reported in this paper is classifiable under three heads: (1) the study of length of instars and of the life history in relation to different conditions of temperature, humidity, light, etc.; (2) the study of the success of cultures under conditions similar to those under which the instars were studied; and (3) the study of the records of abundance, migration, rise, and decline of the pest in the State of Illinois since 1840.

The work on the chinch bug began with preliminary experiments in 1916 and closed with a few low-temperature experiments in 1926. None of the 1916 data proved to be of such a nature that conclusions could be drawn from them. Chinch bug cultures, however, were carried through the greater part of each summer for ten years. Unfortunately, this was an accessory bit of work, carried on chiefly in connection with codling moth experiments (Shelford, 1927) and made feasible by the fact that the apparatus was running. The same chambers were frequently used for both insects in the earlier years; that is, codling moth pupae were put into the chinch bug cages. The two in no way interfered with each other.

After the codling moth work was completed, chinch bugs were run through the few additional summers to check on the preceding work, but in no case was it possible to improve very greatly the preliminary work. The author gave three-fourths of his time to instruc-

tion or other duties; his assistants were devoting most of their time to the engineering curriculum. This is unfortunate because if there is any insect requiring the undivided attention of investigators while the work is in progress, it is the chinch bug. Its persistence and viability varies greatly from year to year. The variation in length of instar periods is much greater than that of most invertebrates. Its habits are such that observation is difficult and special methods are necessary under many conditions. The populations of chinch bugs on the food plants will find their way below the surface of the soil and under the leaf-sheathes, so that nothing but a complete submergence of the plant will insure the observation of all the individuals.

The general results of these experiments, therefore, must be regarded as provisional, and it is hoped that they may afford a basis for intensive study by other workers. At least two observers, with the best possible equipment, should devote all their attention to such a study over a period of two or three years. Finally, of course, the authenticity of results will depend chiefly upon the observation of considerable numbers of life histories carried through under outdoor conditions in addition to cultures, the success of which is determined by the increase, decrease, or dying out of the population. Difficulties of maintaining the cultures are very great. Records of complete life histories of individuals, from egg to adult, are lacking in our work. The quality of the food plants probably differs under different conditions, and identical results cannot be expected from bugs fed on plants actually growing under favorable conditions and those fed on cut plants. A great many observations on the rate of growth and success of any species under variable conditions are essential to bridge the gap between the constant-temperature experiments and fluctuating weather conditions. It was on account of our experience with the codling moth, for which such observations were available, that the very important connection between outdoor progress and the laboratory experiments could be provisionally established for the chinch bug in the form of trial velocity charts.

Equipment and Operation

The laboratory and the general equipment have been described and figured previously (Shelford, 1929, pp. 400-411). The principal chambers used in this work consisted of a two-room unit (*op. cit.*, Figs. 169 and 170) designed to run at two approximately constant temperatures, with humidity control for the separate rooms and with sockets for artificial lights. There were five other chambers (half as large as the improved form shown in Fig. 177) designed to give daily variations in temperature simulating natural days. Some cages were

also used in the glass-roofed house. For the study of length of instars it was necessary to isolate individual nymphs and observe their moultings. This was done in glass cages (Fig. 178), each of which was ventilated by a suction pipe (Fig. 179). Ventilation in most of the other experiments was by means of compressed air from the University Power Plant. The air flow, which was adjusted so as to be comparable to that observed in the field, was measured with diaphragm chambers and attached gages (pp. 241-245). Moisture was removed by Crane oil separators (Fig. 100). In the approximately constant temperature chambers the temperature was controlled by means of recirculating ducts (Fig. 93), and the humidity was controlled by means of mixing tanks (perfected design shown in Fig. 176), to which dry air was supplied from the dehumidifier (Fig. 111) and moist air from a humidifier (similar to that shown in Fig. 109). The humidity control for the variable-temperature units consisted of a spray chamber (Fig. 110), which gave a constant humidity at the temperature of the spray water and gave variation in the chambers as the temperature rose and fell. Livingston porous cup atmometers were used in practically all the experiments, though correlations with rate of evaporation did not prove to be important in this or other experimental work. The rate of evaporation represents a summation of different factors which often have opposite effects on the rate of development of insects. Attempts were made to vary the light surrounding the chinch bugs, but the equipment was not well designed for this purpose. The chamber windows consisted of either double or triple window glass, which shut out a large part of the light. Artificial daylight was provided with incandescent lamps and daylight ray filters inside the cages. Arc lamps and 1000-watt daylight bulbs were also used outside the cages.

The experimental procedures, including the methods of recording the observations and calculating the results, as well as the concepts of developmental units and totals, have been explained in connection with the codling moth (Shelford, 1927).

LENGTH OF INSTAR PERIODS AND THE LIFE HISTORY

The life cycle of the chinch bug is comprised of the egg stage, five nymphal stages, or instars, and the adult stage (from the time of moulting until egg-laying is finished). The determination of the length of the life cycle should be made with continuous observations of single individuals, and the difficulties here are rather great. No individual was traced through from the egg to the adult condition in the experiments here reported. The reason for this is evident from an inspection of Figs. 14-25 and from the following résumé of the records.

Methods and Results

In the year 1916, only preliminary experiments were carried on, and we were successful in getting the bugs to breed. In 1917 the bugs bred, but the conditions under which they were kept, coupled with the condition of the bugs themselves, were such that they in no case became at all abundant in the cultures, and most of the cultures died out early in the season. In 1918 the culture work went forward better than the preceding year. Attempts in these years to study the length of instar periods in U-chloride tubes through which a small amount of air was slowly forced, were generally unsuccessful.

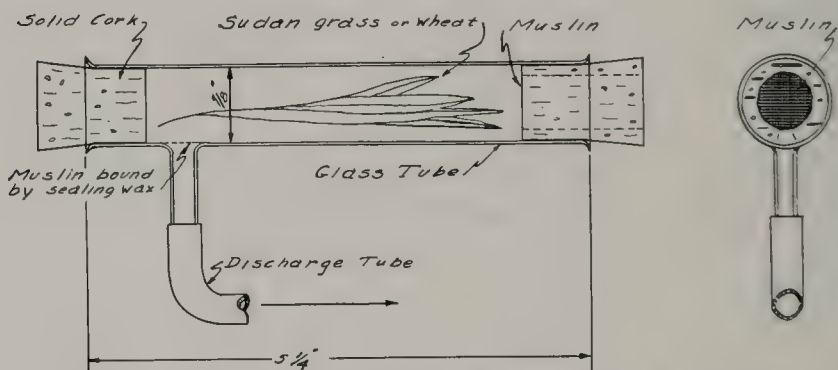


Fig. 1. Plan of tube used inside the culture cages to isolate individuals for the study of length of instars. Circulation was produced by suction.

In 1919 over 500 individuals of different stages were put under observation, but we were unsuccessful with all but 50 of the attempts to carry individuals through a complete single instar. It was thought in 1919 that a piece of cut grass could be placed in a vial and corked with the young bug, but the evaporation from the food materials saturated the air in the small container, so that moisture was precipitated on the sides, and the younger bugs in particular became wet, stuck to the glass, and died. This was the chief cause of our losses, though the tubes with air forced slowly through them and the tubes to which suction was applied (Fig. 1) did not yield a very large number of definite records. A large expenditure of energy gave few or no results, and for some stages no records of length of stage were obtained in that year.

In 1920 the suction system referred to in the description of the apparatus was put into use, the suction tubes being placed in the

cultures adjacent to the food plants. The rate at which the air was drawn out of the cage was adjusted so as to be approximately the same as the rate of flow in the normal habitat of the insect. Extremes of humidity, both high and low, were avoided. The results were much better than in previous years. About 80 records were obtained out of 150 to 200 possibilities.

In 1921 the observations were made by Dr. H. Yuasa, a well-known Japanese entomologist then employed by the Natural History Survey and now of the Imperial University, Kyoto, Japan, and at least 75 records were obtained out of about 200 possibilities. The

TABLE I
APPROXIMATELY CONSTANT TEMPERATURE

Showing length of stage for comparable groups of individuals subjected to small variations in temperature and relative humidity. The mean of the highest and lowest numbers of days in each grouping was used as the basis for calculating the percentage of variation. There were two observations per day in some cases, as indicated by half-days in some of the records.

Designation	Year	Temperature (mean degrees C.)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+ - %)	Remarks
EGG STAGE								
AL	1921	23.1	86.0	8/9, 8/29	20	19	5.2	
AL	1921	23.1	86.0	8/11, 8/29	18			
BW	1921	30.4	94.2	8/9, 8/18	9	8	12.5	
BW	1921	30.5	94.7	8/11, 8/18	7			
BW	1922	31.4	91.0	7/19, 7/27	8	8	0.0	
BW	1922	31.4	91.0	7/19, 7/27	8			
BW	1925	27.0	40.0	7/28, 8/15	18	16	12.5	
BW	1925	27.0	40.0	7/24, 8/7	14			
AVERAGE							7.5	
FIRST INSTAR								
BW	1922	31.1	92.1	7/27, 8/3	7	5.5	27.3	
BW	1922	31.0	92.5	7/27, 7/31	4			
BW	1925	29.0	85.0	9/21, 9/26	5	4.0	25.0	
BW	1925	29.0	85.0	8/23, 8/26	3			
BW	1925	29.0	85.0	8/15, 8/20	5			
BD	1925	29.0	40.0	8/7, 8/18	11	8.5	29.4	
BD	1925	29.0	40.0	8/8, 8/14	6			
AVERAGE							27.2	

TABLE I—Cont'd

Designation	Year	Temperature (mean degrees C.)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+ - %)	Remarks
SECOND INSTAR								
AW	1922	22.1	94.0	7/21, 7/31	10	10.0	0.0	
AW	1922	22.0	94.1	7/23, 8/2	10			
BD	1925	29.0	40.0	8/14, 8/19	5	5.5	9.1	
BD	1925	29.0	40.0	7/20, 7/26	6			
BW	1925	29.0	85.0	8/26, 9/7	12	10.0	20.0	
BW	1925	29.0	85.0	7/20, 7/28	8			
AVERAGE							9.7	
THIRD INSTAR								
BWW	1920	29.1	92.6	8/7, 8/10	3	3.0	0.0	
BWW	1920	29.5	93.3	8/10, 8/13	3			
BWW	1920	28.3	91.3	8/19, 8/22	3	3.5	14.3	
BWW	1920	28.6	91.2	8/18, 8/21	3.5			
BWW	1920	28.4	91.2	8/19, 8/23	4			
BW	1922	32.2	91.3	8/3, 8/7	4	5.5	27.3	
BW	1922	32.2	91.6	8/3, 8/10	7			
AL	1925	26.0	84.9	7/23, 8/5	13	9.0	44.4	
AL	1925	26.0	85.4	7/27, 8/1	5			
BW	1921	29.1	92.9	9/4, 9/9	5	5.0	0.0	
BW	1921	29.4	93.7	9/5, 9/10	5			
AWLL	1921	23.6	90.5	7/30, 8/3	4	5.5	27.3	
AWLL	1921	23.8	90.4	8/3, 8/8	5			
AWLL	1921	23.6	90.6	7/30, 8/6	7			
AWLL	1921	23.8	92.0	8/28, 9/2	5			
B	1925	29.0	85.0	9/7, 9/11	4	6.5	38.5	
B	1925	29.0	85.0	9/21, 9/25	4			
B	1925	29.0	85.0	9/18, 9/23	5			
B	1925	29.0	85.0	8/8, 8/17	9			
B	1925	29.0	40.0	7/22, 8/8	17	12.5	36.0	
B	1925	29.0	40.0	8/24, 9/1	8			
B	1925	29.0	40.0	7/26, 8/5	10			
AW	1926	20.9	92.8	7/27, 8/4	8	9.0	11.1	
AW	1926	20.9	92.8	7/28, 8/5	8			
AW	1926	20.9	91.8	7/22, 7/30	8.5			
AW	1926	20.9	92.6	7/25, 8/4	9			
AVERAGE							22.1	

TABLE I—Cont'd

Designation	Year	Temperature (mean degrees °)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+ - %)	Remarks
FOURTH INSTAR								
BWW	1920	28.3	91.3	7/19, 7/22	3	3.0	0.0	
BWW	1920	28.3	90.5	8/4, 8/7	3			
BWW	1920	29.1	92.8	7/6, 7/9	2.5	3.25	23.1	
BWW	1920	29.1	92.7	7/6, 7/10	4			
AWL	1921	23	86.7	8/6, 8/13	7	9.0	22.2	
AWL	1921	23	86.5	8/17, 8/28	11			
BW	1921	30.5	93.8	8/5, 8/8	3	3.25	7.7	
BW	1921	30.4	93.8	8/4, 8/7	3.5			
AW	1922	21.6	93.3	8/2, 8/16	14	10.5	33.3	
AW	1922	21.8	93.7	7/15, 7/22	7			
AW	1922	21.7	93.5	7/12, 7/20	8			
BW	1922	32.6	91.1	8/10, 8/17	7	6.0	33.3	
BW	1922	32.2	91.5	8/3, 8/10	7			
BW	1922	32.8	90.5	8/12, 8/16	4			
BW	1922	32.0	91.5	8/3, 8/11	8			
BW	1922	32.6	91.1	8/10, 8/17	7			
AL	1925	25.6	86.1	7/29, 8/3	5	4.5	11.1	
AL	1925	25.8	86.4	8/1, 8/5	4			
ADK	1925	26.7	89.1	9/12, 9/18	6	5.0	20.0	
ADK	1925	26.7	89.1	9/28, 10/2	4			
ADK	1925	27.3	87.8	9/20, 9/25	5	5.5	9.1	
ADK	1925	27.3	87.2	9/14, 9/20	6			
AD	1926	20.9	33.8	7/24, 8/3	10	9.25	8.1	
AD	1926	20.8	33.2	7/26, 8/4	8.5			
BD	1926	30.2	33	7/23, 7/26	3	3.25	23.1	
BD	1926	30	33	7/19, 7/23	4			
BD	1926	30.6	33	7/23, 7/25	2.5			
BD	1926	29.5	33	7/24, 7/28	3.5			
AVERAGE							17.4	
FIFTH INSTAR								
BWW	1920	29.3	93	7/8, 7/13	5	6.0	25.0	
BWW	1920	29.1	92.2	7/13, 7/17	4.5			
BWW	1920	29.3	92.9	7/6, 7/12	6			
BWW	1920	29.3	92.9	7/7, 7/13	6			
BWW	1920	29.2	92.7	7/10, 7/18	7.5			
ALL	1921	23.3	94.9	9/14, 9/24	10	11.5	13.0	
ALL	1921	23.4	94.0	9/9, 9/22	13			
A	1922	22	93.5		12.5	12.5	40.0	Average of 4 readings
A	1922	22.8	92	7/8, 7/18	10	10.0	0.0	
A	1922	22.8	92.2	7/9, 7/19	10			
B	1925	29	40	9/15, 10/28	7.5	8.5	12.5	Average of 10 readings

TABLE I—Cont'd

Designation	Year	Temperature (mean degrees C.)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+ - %)	Remarks
FIFTH INSTAR—CONT'D								
B	1925	29	85	7/29, 8/23	7	6.5	39.0	Average of 9 readings
ALL	1925	29.1	80	9/4, 9/20	6	6.5	7.7	
ALL	1925	29.1	81.5	8/23, 8/30	7			
ALL	1925	29.7	80.6	9/17, 9/23	6			
ALL	1925	29.6	81.0	9/27, 10/3	6			
AD	1926	21.1	29.0	7/4, 7/17	12.5	12.75	2.0	
AD	1926	21.1	29.1	7/3, 7/16	13			
AW	1926	21.1	93.1	7/25, 8/8	14	13.25	5.7	
AW	1926	21.1	93	7/27, 8/9	12.5			
BD	1926	30	33	7/21, 7/27	6	6.0	16.6	
BD	1926	29.8	33	7/23, 7/28	5			
BD	1926	29.5	33	7/28, 8/3	6			
BD	1926	29.4	33	7/27, 8/3	7			
BW	1926	29.6	92.6	7/25, 7/30	5	5.0	10.0	
BW	1926	29.6	93	7/25, 7/29	4.5			
BW	1926	29.8	92.4	7/23, 7/28	5.5			
BW	1926	29.6	92.6	7/25, 7/30	5			
AVERAGE							15.6	
AVERAGE FOR ALL STAGES							16.6	

survival of the bugs, however, did not become much higher than this in any of the subsequent work.

In 1925 an additional method was tried which yielded a few results. Test tubes were inverted over growing Sudan grass or wheat, so as to give a saturated atmosphere when desired. The bugs bred and some of the nymphs became adults. About 20 records of length of instar periods were obtained. The writer believes, however, that some modification of this method might be used to yield much better results than any of the other methods. Air could be forced in at the bottom and allowed to pass up around the plant if tubes of a design similar to that shown in Fig. 1 were properly inserted in the ground. In any case, extremely wet conditions have to be avoided, however desirable it is to test them.

In all, 682 life history stages were observed as to time required for each, while temperature and humidity were recorded with moderate accuracy. Of these, 387 were under the less variable temperature

conditions, with a daily range of 1-7°C., and 295 were under more variable conditions, with a daily variation of 10-16°C. These observations were distributed as follows: egg, 34; first instar, 55; second, 67; third, 121; fourth, 190; fifth, 215. Tables I-IV show selected data in connection with the length of instar periods, but only those that could be paired for comparison.

The lengths of the several stages at 90% relative humidity and 23°C. mean temperature with 4° or 5° daily variation are estimated to be as follows: egg, 16.5 days; first instar, 6.0 days; second, 5.9 days; third, 5.7 days; fourth, 6.1 days; fifth, 11.2 days; the sum being 51.4 days. The period from egg to adult, on the basis of the combined data shown in Fig. 10 and Table V, is 52.2 days. The average time obtained by taking the sum of the several stages at three combinations of temperature and humidity is shown in Table VI.

TABLE II
VARIABLE TEMPERATURE

Showing length of stage for comparable groups of individuals under more variable temperature than in Table I but with only slight differences in mean relative humidity. The temperature conditions simulated the normal daily fluctuations out of doors (10°C. rise and fall). Percentages were calculated as in Table I. Data for 1919 are omitted because there were no two comparable groups.

Designation	Year	Temperature (mean degrees C.)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+-%)
EGG STAGE							
F	1922	26.0	96.8	7/19, 7/27	8	10.0	20.0
G	1922	26.9	95.1	7/19, 7/31	12		
G	1922	28.1	91.5	8/3, 8/7	4	3.5	14.3
G	1922	28.1	91.3	8/3, 8/6	3		
G	1925	30.3	81.4	7/31, 8/7	7	5.0	40.0
G	1925	30.9	81.5	8/3, 8/6	3		
AVERAGE							24.8
FIRST INSTAR							
C	1922	23.8	89.4	8/1, 8/12	11	8.0	37.5
E	1922	23.8	86.4	8/16, 8/21	5		
F	1925	31.5	76.3	8/18, 8/25	7	6.5	7.7
F	1925	31.5	76.6	8/20, 8/26	6		
G	1925	30.1	83.3	9/18, 9/28	10	9.5	5.3
G	1925	30.5	83.8	9/16, 9/25	9		
AVERAGE							16.8

TABLE II—Cont'd

Designation	Year	Temperature (mean degrees C.)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+-%)
SECOND INSTAR							
F	1922	26.6	99.5	8/12, 8/16	4		
G	1922	26.8	99.5	8/21, 8/28	7	5.5	27.0
AVERAGE							27.0
THIRD INSTAR							
F	1920	30.3	79.6	7/6, 7/10	3.5		
G	1920	30.9	79.9	7/6, 7/10	4	3.75	6.7
FW	1921	27.0	84.9	9/17, 9/21	4		
GD	1921	27.7	83.1	8/7, 8/10	3	3.5	14.3
F	1922	29.5	93.5	8/31, 9/10	10		
F	1922	29.5	93.5	8/31, 9/10	10	10.0	0.0
F	1925	32.7	86.5	9/12, 9/18	6		
F	1925	32.5	89.1	8/4, 8/10	6	6.0	0.0
E	1925	34.4	74.5	9/11, 9/15	4		
E	1925	34.6	75.3	9/11, 9/14	3	3.5	14.3
AVERAGE							7.1
FOURTH INSTAR							
E	1920	22.1	95.2	7/7, 7/14	7		
E	1920	21.8	95.3	7/18, 7/23	5	6.0	16.6
E	1920	21.9	95.3	7/19, 7/25	6		
F	1920	31.1	76.7	7/10, 7/12	2.5		
G	1920	31.3	76.3	7/5, 7/8	3.5	3.0	16.6
EW	1921	24.0	84.0	8/5, 8/13	8		
EW	1921	23.5	84.6	8/11, 8/19	8	8.0	0.0
G	1925	27.7	83.7	7/27, 8/1	5		
G	1925	28.5	83.9	7/26, 7/31	5	5.0	0.0
G	1925	30.8	76.2	9/27, 9/30	3		
G	1925	30.9	75.0	8/10, 8/17	7	5.0	40.0
E	1925	33.4	74.1	9/15, 9/19	4		
E	1925	33.6	72.5	9/14, 9/18	4	4.0	0.0
AVERAGE							12.2
FIFTH INSTAR							
G	1920	29.0	86.5	7/18, 7/23	5.5		
G	1920	29.0	86.5	7/19, 7/24	5	5.25	4.7
G	1920	27.2	84.3	7/21, 7/27	6		
G	1920	27.2	84.3	7/21, 7/26	5.5	5.75	4.3
D	1922	23.4	93.0	7/14, 7/24	10		
D	1922	23.4	94.0	7/15, 7/26	11	10.5	4.8

TABLE II—Cont'd

Designation	Year	Temperature (mean degrees C.)	Relative humidity (mean %)	Dates, beginning and ending	Length of stage (days)	Mean of extremes (days)	Variation (+-%)
FIFTH INSTAR—CONT'D							
F	1922	25.2	96.0	7/6, 7/12	6	6.5	7.7
F	1922	25.0	96.3	7/7, 7/14	7		
E	1925	34.4	85.3	8/17, 8/20	3	3.5	14.3
F	1925	34.0	85.6	9/17, 9/21	4		
G	1925	29.7	80.2	9/24, 10/2	8	6.0	33.3
E	1925	29.2	80.1	8/20, 8/24	4		
G	1925	29.5	76.6	8/18, 8/23	5	6.5	23.1
G	1925	30.2	76.1	8/17, 8/25	8		
E	1925	30.9	82.1	9/18, 9/23	5	5.5	9.1
E	1925	30.9	82.4	9/19, 9/25	6		
F	1925	32.1	75.1	8/16, 8/21	5	5.0	0.0
F	1925	32.6	75.7	8/13, 8/18	5		
F	1925	32.1	79.4	8/10, 8/16	6	6.0	0.0
G	1925	32.9	79.0	10/13, 10/19	6		
G	1925	33.5	77.0	10/15, 10/22	7	6.0	16.7
G	1925	33.6	77.0	10/16, 10/21	5		
AVERAGE							10.7
AVERAGE FOR ALL STAGES							16.4

Individual Variation

First of all, it is desirable to know the amount of individual variation. The 682 records of stages reveal a surprising amount of variation as to the duration of the same stage under nearly the same conditions. They are, however, so scattered in the years 1919-1922 and 1924-1926 as to permit comparison of only a few. Only paired cases were used to estimate the individual variation.

In Table I the individual variation in the length of all stages at approximately constant temperatures is shown to have averaged $\pm 16.6\%$ of the mean. (The plus or minus percentage was calculated from the mean of the longest and shortest periods under the same conditions; thus a variation of $\pm 20\%$ indicates that when the time is 5 days for the average individual it may be 6 days for the slowest individual, or 4 for the most rapidly developing one.) The average deviation from the mean for the egg is 1.5%, for the first stage 21.2%,

second stage 9.7%, third stage 22.1%, fourth stage 17.1% and fifth stage 15.6%. A similar range of variation under more variable temperatures is indicated in Table II, where the average for the egg stage is 24.8%, for the first instar 16.8%, for the second 27%, third 21%, fourth 12.2%, and fifth 10.7%, and the average for all stages 16.4%.

These variations are rather large, as compared to the 8% deviation found in the codling moth pupae and percentages of the same order of magnitude in the other stages of the moth (Shelford, 1927). It is evident, therefore, that individual variation may render the results in small series of observations quite irregular, and this consideration further lessens the weight to be given to the smaller number of cases.

Effect of Humidity

The study of instars brought out the great importance of moisture. While high atmospheric humidity is favorable, especially to the early instars, actual liquid water is detrimental or fatal.

Data on all instars from the same stock which were kept under the same temperatures but different humidities are presented in Tables III and IV to show effects of humidity upon length of stage. The average increase in the length of instars per 10% decrease in relative humidity is 25-35%. Generally speaking, the effect of the lowest humidity is greatest in the first and second nymphal stages.

The numerical relation of the length of life history stages of animals to atmospheric moisture (at any fixed temperature) has been but little studied. It is evident, however, that none of the formulae used to express relations to temperature can ordinarily be used and that insects differ greatly as to amount of effect produced by a given difference in atmospheric moisture, expressed as relative humidity in per cent saturation, as saturation deficit, or otherwise. The effect of moisture on the length of chinch bug stages is relatively great. It approaches more nearly a direct proportionality to per cent relative humidity than in many other organisms. Accordingly, to compare the different stages and gain a concept of the magnitude of the effect of humidity on the rate of development of the chinch bug, the data have been reduced to a common basis of 10% difference in relative humidity. This was necessitated by the great differences in humidity for the surviving stage-completing individuals.

The theoretical percentage increase in time with a decrease of 10% relative humidity was calculated as a direct proportion of the difference which occurred in each case. Suppose, for example, two individuals passing through the same stage at the same temperature, one in 10 days at 50% relative humidity, another in 5 days at 90% relative

TABLE III
HUMIDITY DIFFERENCES

Showing estimated difference in length of stage in groups kept under different conditions of relative humidity and subjected to only small daily fluctuations in temperature, the mean temperature being approximately the same within each group. (Differences of not more than two-tenths of a degree in mean temperature are not regarded as significant.) The differences correlated with relative humidity are estimated on the basis of a 10% change to facilitate comparison. For further explanation see text.

a. Designation	b. Year	c. Dates, beginning and ending	d. Length of stage (days)	e. Temperature (mean degrees C.)	f. Relative humidity (mean %)	g. Difference in mean percentages of relative humidity	h. Estimated number of days at a relative humidity 10% lower than the highest percentage in column f	i. Estimated quotient obtained with decrease of 10% relative humidity	j. Theoretical percentage increase in time with decrease of 10% relative humidity	k. Remarks
EGG STAGE										
B	1922	7/19, 7/27	8	31.4	91	2	16.0	2.66	166	Not averaged
B	1922	8/25, 8/31	6	31.8	93					
B	1925	7/24, 8/7	14	27.7	40	44	11.68	1.06	6	
ALL	1925	8/1, 8/12	11	27.9	84					
B	1925	7/28, 8/15	18	27.6	40	50	10.8	1.20	20	
B	1925	7/30, 8/8	9	27.1	90					
AVERAGE									13	Average of all = 64
FIRST INSTAR										
BM	1919	4/7, 4/25	18	28.2	72	13	15.0	3.00	200	Not averaged
BW	1919	4/2, 4/7	5	28.3	85					
BM	1919	4/7, 4/25	18	28.2	72	18	14.0	1.55	55	
BW	1919	6/12, 6/21	9	28.3	90					
BD	1925	8/7, 8/18	11	29.0	40	45	6.33	1.26	26	
BW	1925	8/15, 8/20	5	29.0	85					
BD	1925	8/8, 8/14	6	29.0	40	45	3.66	1.22	22	
BW	1925	8/23, 8/26	3	29.0	85					
BD	1925	8/8, 8/14	6	29.0	40	45	5.20	1.05	5	
BW	1925	8/15, 8/20	5	29.0	85					
AVERAGE									27	Average of all = 61
SECOND INSTAR										
BM	1919	8/11, 9/1	21	28.0	71	26	11.77	1.96	96	
BWW	1919	8/6, 8/12	6	28.5	97					
BM	1919	4/25, 5/2	7	28.4	74	23	6.43	1.07	7	
BWW	1919	8/6, 8/12	6	28.5	97					
BD	1925	8/14, 8/19	5	29.0	40	45	7.33	.91	-9	Not averaged
BW	1925	7/20, 7/28	8	29.0	85					
AVERAGE									51	Average of all = 31

TABLE IV

SIMULATION OF DAILY MARCH OF TEMPERATURE AND RELATIVE HUMIDITY

Showing estimated difference in length of stage at the same mean variable temperature simulating the usual day of the season, but under different conditions of relative humidity represented by the mean of percentages ranging lower as the varying temperature went higher, and *vice versa*, in a manner similar to the normal daily march of relative humidity. Otherwise, the treatment of the data is the same as in Table III. Further data as to temperature variation may be secured from Table VII.

a. Designation	b. Year	c. Dates, beginning and ending	d. Length of stage (days)	e. Temperature (mean degrees C.)	f. Relative humidity (mean %)	g. Difference in mean percentages of relative humidity	h. Estimated number of days at a relative humidity 10% lower than the highest percentage in column f	i. Estimated quotient obtained with decrease of 10% relative humidity	j. Theoretical percentage increase in time with decrease of 10% relative humidity	k. Remarks
FIRST INSTAR										
E	1925	8/19, 8/27	8	31.3	80.5	14	6.6	2.20	120	Not averaged
E	1925	8/7, 8/10	3	31.3	94.5					
E	1925	9/26, 10/4	8	33.9	71.0	7	8.43	1.20	20	
E	1925	9/8, 9/15	7	33.9	78.0					
F	1925	8/18, 8/25	7	31.5	76.3	4	8.5	1.40	40	
E	1925	8/22, 8/28	6	31.6	80.1					
AVERAGE									30	Average of all = 60
SECOND INSTAR										
F	1919	6/15, 6/20	5	33.3	91.9	5	6.0	1.50	50	
F	1919	5/17, 5/21	4	33.5	96.7					
E	1922	8/14, 8/21	7	23.7	87.0	10	7.0	1.40	40	
D	1922	7/22, 7/27	5	23.7	97.0					
E	1925	9/5, 9/11	6	31.4	84.6	5	9.0	3.00	200	Not averaged
E	1925	8/10, 8/13	3	31.4	90.0					
AVERAGE									45	Average of all = 97
THIRD INSTAR										
E	1921	9/29, 10/4	5	28.0	72.5	12	4.8	1.20	20	
F	1921	9/17, 9/21	4	27.0	84.9					
G	1925	8/5, 8/12	7	31.0	80.0	10	7.0	1.75	75	
F	1925	8/5, 8/9	4	31.3	90.6					
E	1925	8/13, 8/19	6	33.4	78.2	14	0	0	0	
E	1925	8/6, 8/12	6	32.3	92.2					
AVERAGE									33	Average of all = 33

TABLE V
COMBINED VELOCITY VALUES

Showing developmental units per hour for the life history of the chinch bug, from the laying of the egg to the emergence of the adult (6800 units).

Temperature		Relative humidity percentage															
C.	F.	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
48	118.4	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
47	116.6	0.4	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.2	0.2	0.1	0.0
46	114.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.3
45	113.0	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.6
44	111.2	1.5	1.6	1.6	1.6	1.7	1.7	1.6	1.6	1.5	1.5	1.4	1.3	1.2	1.1	1.0	0.9
43	109.4	1.9	1.9	1.9	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2
42	107.6	2.2	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.4	2.3	2.1	2.0	1.9	1.8	1.7	1.6
41	105.8	2.9	3.0	3.1	3.2	3.3	3.3	3.3	3.3	3.2	3.1	2.9	2.8	2.5	2.4	2.1	1.9
40	104.0	3.5	3.7	3.8	3.9	4.0	4.1	4.2	4.2	4.1	4.0	3.9	3.7	3.5	3.1	2.9	2.6
39	102.2	4.0	4.3	4.4	4.7	4.9	5.0	5.1	5.2	5.3	5.1	5.0	4.9	4.6	4.2	4.0	3.7
38	100.4	4.6	4.9	5.1	5.4	5.6	5.9	6.1	6.2	6.2	6.2	6.1	6.0	5.8	5.5	5.2	4.7
37	98.6	5.0	5.4	5.8	6.1	6.4	6.8	7.0	7.1	7.2	7.2	7.2	7.1	6.8	6.5	6.2	5.8
36	96.8	5.3	5.8	6.3	6.7	7.1	7.5	7.8	8.1	8.2	8.3	8.3	8.1	7.9	7.6	7.3	6.9
35	95.0	5.4	6.0	6.5	7.1	7.6	8.1	8.6	8.9	9.1	9.3	9.3	9.3	9.1	8.9	8.5	8.1
34	93.2	5.3	5.8	6.5	7.1	7.8	8.4	8.9	9.4	9.9	10.1	10.3	10.3	10.1	9.9	9.6	9.2
33	91.4	5.1	5.7	6.3	6.9	7.6	8.3	9.0	9.6	10.2	10.7	11.1	11.1	11.1	10.9	10.6	10.3
32	89.6	4.8	5.3	5.9	6.5	7.2	8.0	8.7	9.4	10.1	10.7	11.3	11.7	11.9	11.7	11.5	11.0
31	87.8	4.4	4.9	5.4	6.1	6.7	7.4	8.2	8.9	9.7	10.4	11.1	11.8	12.3	12.3	12.1	11.9
30	86.0	3.9	4.4	4.9	5.4	6.1	6.7	7.4	8.2	8.9	9.7	10.5	11.2	12.0	12.3	12.2	12.2
29	84.2	3.3	3.7	4.2	4.7	5.4	5.9	6.6	7.3	8.0	8.8	9.4	10.2	11.2	11.7	12.0	12.1
28	82.4	2.7	3.1	3.5	4.0	4.5	5.1	5.7	6.3	7.0	7.7	8.4	9.1	9.7	10.6	11.2	11.5
27	80.6	2.0	2.4	2.8	3.3	3.7	4.1	4.8	5.3	5.9	6.6	7.2	7.9	8.6	9.3	10.0	10.8
26	78.8	1.5	1.8	2.1	2.5	2.9	3.3	3.8	4.3	4.9	5.5	6.1	6.9	7.5	8.1	8.9	9.6
25	77.0	1.1	1.4	1.7	1.9	2.2	2.5	3.0	3.4	4.0	4.5	5.1	5.8	6.4	7.1	7.8	8.4
24	75.2	0.7	0.9	1.1	1.3	1.5	1.8	2.2	2.5	3.0	3.4	4.0	4.6	5.3	6.0	6.6	7.3
23	73.4	0.4	0.6	0.8	0.9	1.1	1.3	1.5	1.8	2.2	2.7	3.1	3.6	4.2	5.0	5.6	6.2
22	71.6	0.2	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.6	1.9	2.2	2.8	3.2	3.9	4.5	5.1
21	69.8	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.4	1.6	1.9	2.3	2.9	3.3	4.0
20	68.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.2	1.4	1.7	2.0	2.4	3.0
19	66.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.8	1.1	1.4	2.0
18	64.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.6	0.8	1.1	1.4
17	62.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.9
16	60.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5
15	59.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

TABLE VI
LENGTH OF LIFE CYCLE

Showing average time from egg to adult, determined by adding together the averages for the instar periods under conditions not differing by more than 1.5°C. and 4% relative humidity.

Designation	Mean temperature °C.	Mean relative humidity %	Length of life cycle in days
A	22.0	92	59.5
B	28.9	46	45.2
B	30.1	93	31.4

humidity. The difference in relative humidity is 10% and the difference in time is 5 days; therefore, the difference in length of stage corresponding to a 10% difference in humidity would be one-fourth of 5 days, or 1.25 days. Hence, the time at 80% would be 5 plus 1.25, or 6.25 days, and the ratio of the time at the higher humidity to the time at the lower humidity is 6.25:5, or 1.25. This may be compared with the Q_{10} for temperature and may be designated as $Q_{10}\%$.

In the first item in Table III, where the difference in time is 2 days, the value of $Q_{10}\%$, or the estimated effect of a 10% difference in humidity, is calculated as follows:

$$10\% \div 2\% = 5$$

$$2 \text{ days} \times 5 = 10 \text{ days}$$

$$10 \text{ days} + 6 \text{ days} = 16 \text{ days (column } h)$$

$$16 \text{ days} \div 6 \text{ days} = 2.66 \text{ (column } i)$$

The values in Table IV are calculated in the same way.

Thus all the values are calculated from the high favorable humidity to the low unfavorable humidity and expressed here as retardation rather than acceleration. It is noteworthy that a decrease in humidity causes a decrease in rate which is expressed in the tables as longer time for development of the stage in question. The facts are expressed in this form because the higher humidities are usually more favorable within the limits shown. Occasionally the relation is reversed, as indicated by the two negative values in column *j* of Table III. These and a class of exceptions to the usual rule, namely, percentages above 100, of which there are two in Table III and five in Table IV, probably result from the individual variation indicated in Tables I and II and discussed in the preceding section. The averages in column *j* have been taken without the negative values and without the items above 100%. The averages with these included are shown opposite in column *k*.

Table III includes items from 1919 to 1925 shown in Table VII to be characterized by an average daily range of less than 8°C. Table IV includes those with a greater daily range (more than 10°C.). The results are, however, generally comparable. It is noteworthy that the difference in humidity has the greatest effect in the first stage and the least effect in the last stage. It is also noteworthy that a decrease of 10% in humidity has a greater effect under the more variable temperatures.

Velocity Curves and Charts

On the basis of these generalizations and some plots of all available data, velocity curves and provisional charts for rate of development have been prepared, as shown in Figs. 2-8, by the method used

TABLE VII
CULTURAL CONDITIONS

Showing averages for each season, 1917-1925, with notes on the success of the cultures. The asterisk indicates groups from which instars were selected for use in Tables III and IV. Data in Tables I and III (for groups with a mean daily range of less than 8°C.) and in Tables II and IV (for groups with a greater daily range) are averages for each stage of the insect and therefore do not agree with the averages shown here for the entire season.

Designation	Mean of maxima (C.)	Mean of minima (C.)	Mean daily range (C.)	Mean of bi-hourly readings (C.)	Mean relative humidity (%)	Evaporation (cc. per day)	Illumination (refer to curves in Figs. 12 and 13)	Per cent of noon sunlight	Number of times started	Remarks on success of culture
1917										
AD	23.4	18.8	4.6	21.1	50	10.65	I	9.5	1	Fair
AM	23.4	18.6	4.8	21.0	80	3.28	I	9.5	1	Fair
BD	28.3	23.2	5.1	25.9	45	11.30	I	9.5	1	Fair
CD	40.8	30.7	10.1	31.7	55	.....	VII	8.0	1	Best
D	41.0	30.7	10.3	32.1	95	1.88	VII	8.0	1	Best
E	40.7	29.8	10.9	31.3	100	1.32	X	0.5	1	Fair
F	41.0	32.0	9.0	33.4	100	.....	VII	8.0	1	Fair
1918										
AW	21.8	21.4	0.4	21.6	77.5	7.77	II	3.5	1	Weak
BD	29.6	25.3	4.3	27.5	65.0	10.45	II	3.5	1	Weak
BWL	28.7	27.2	1.5	28.0	75.0	5.76	II	3.0	1	Fair
BWLL	28.1	26.4	1.7	27.2	75.0	5.85	II	5.0	1	Best
F	40.0	22.8	17.2	33.3	68.0	7.10	VII	8.0	1	Poor
1919										
AWa	24.4	19.0	5.4	21.1	81.7	2.98	IV	0.5	1	Failed
AWb	25.4	18.6	6.8	21.2	80.5	6.42	IV	0.5	1	Failed
AD	25.4	18.6	6.8	21.2	80.5	7.07	IV	0.5	1	Weak
*BW	28.8	27.8	1.0	28.3	84.5	5.48	IV	0.5	1	Good
*BWV	28.0	26.6	1.4	27.3	98.0	1.80	IV	0.5	3	Weak
BD	28.4	27.2	1.2	27.8	62.3	.....	IV	0.5	1	Weak
C	40.5	21.9	18.6	31.2	84.0	14.49	IX	2.0	2	Weak
D	41.7	24.6	17.1	30.3	88.5	10.58	IX	2.0	3	Fair
E	41.7	24.6	17.1	30.3	88.5	10.58	X	0.5	1	Best
*F	41.6	27.0	14.6	34.1	97.0	10.58	XII	9.0	1	Better
G	39.3	24.5	14.8	30.9	76.0	11.66	VII	8.0	2	Fair
P	26.1	15.6	10.5	21.6	79.5	.....	.....	9.0	.....	.....
1920										
AW	18.8	15.5	3.3	16.6	95.6	3.62	IV	0.5	1	Failed
BWWa	33.5	29.2	4.3	31.2	90.4	5.5	IV	0.5	1	Fair
BWWb	30.5	28.6	1.9	29.7	91.4	5.23	IV	0.5	1	Fair
C	33.2	26.1	7.1	28.7	95.1	6.66	IX	2.0	1	Poor
D	29.0	20.3	8.7	23.9	92.0	4.0	VII	8.0	1	Good
E	28.9	19.6	9.3	22.7	94.3	29.6	X	0.5	1	Weak
F	34.4	19.3	15.1	25.0	76.5	11.9	XII	9.0	1	Best
G	36.3	20.2	16.1	27.9	76.9	22.9	VII	8.0	1	Good
1921										
*AWL	24.8	20.5	4.3	22.6	89.2	7.8	IV	0.5	3	Fair
*AWLL	26.7	21.5	5.2	24.1	90.4	7.1	III	1.0	3	Fair
BW	32.0	25.2	6.8	28.4	69.9	10.96	IV	0.5	3	Fair
CWL	33.2	21.4	11.8	27.2	95.2	5.33	VI	4.0	3	Weak
CWLL	33.3	21.3	12.0	27.3	93.6	4.33	VII	8.0	3	Fair
DDLL	33.1	19.5	13.6	26.3	85.8	.....	VII	8.0	3	Fair
*EW	30.2	21.0	9.2	25.5	76.6	.....	X	0.5	3	Fair
*FW	40.0	26.4	13.6	33.2	76.2	.....	XII	9.0	3	Fair
GD	40.8	26.2	14.6	33.5	84.7	.....	VII	8.0	3	Fair

TABLE VII—Cont'd

Designation	Mean of maxima (C.)	Mean of minima (C.)	Mean daily range (C.)	Mean of bi-hourly readings (C.)	Mean relative humidity (%)	Evaporation (cc. per day)	Illumination (refer to curves in Figs. 12 and 13)	Per cent of noon sunlight	Number of times started	Remarks on success of culture
1922										
*ALL	25.2	18.9	6.3	22.0	90.6	4.5	III	1.0	1	Best
AL	23.8	18.6	5.2	21.2	89.8	2.5	III	1.0	1	Fair
*B	32.8	28.6	4.2	34.3	94.4	7.2	IV	0.5	1	Fair
Ce	34.3	20.7	13.6	27.5	91.1	8.7	VI	4.0	3	Fair
CRw	34.0	18.5	15.5	26.2	92.6	9.37	VII	8.0	2	Fair
*D	32.5	18.4	14.1	25.4	84.7	17.82	VII	8.0	3	Weak
*E	30.5	19.0	11.5	24.7	90.7	9.22	X	0.5	1	Fair
F	35.2	20.2	15.0	22.7	96.0	.....	XII	9.0	3	Fair
G	32.3	20.1	12.2	26.1	94.0	4.68	VII	8.0	2	Fair
1923										
ALL	26.7	21.5	5.2	24.1	84.1	7.3	III	1.0	2	Weak
AL	26.5	21.2	5.3	23.9	86.6	8.6	III	1.0	2	Weak
B	34.1	27.8	6.3	31.0	84.2	10.6	III	1.0	4	Weak
Ce	32.7	22.2	10.5	27.5	96.9	8.2	VII	8.0	1	Best
Cw	32.2	22.2	10.0	27.2	97.2	.....	VII	8.0	1	Best
F	32.2	21.3	10.9	26.7	92.2	7.7	VII	8.0	1	Fair
G	32.9	24.6	10.3	28.7	94.5	.....	VII	8.0	3	Failed
1924										
AL	30.2	23.8	6.4	26.4	86.0	.....	I	9.5	1	Good
ALL	31.9	23.9	8.0	27.5	87.1	.....	I	9.5	2	Fair
B	34.5	23.6	10.9	29.1	84.7	.....	I	9.5	2	Weak
Ew	33.6	22.8	10.8	28.1	80.7	.....	X	0.5	1	Good
Fw	34.0	22.7	11.3	28.3	85.2	.....	XII	8.0	1	Good
G	38.2	27.9	10.3	33.4	74.6	.....	XII	9.0	1	Good
1925										
AL	29.8	23.6	6.2	26.7	98.5	7.5	I	9.5	1	Good
*ALL	30.1	24.6	5.5	27.6	83.9	7.3	I	9.5	1	Best
AR	29.8	24.1	5.7	27.7	83.3	13.1	I	0.5	1	Poor
*BW	32.1	25.4	6.7	28.7	89.6	.....	.....	9.5	1	Fair
*E	36.6	26.9	9.7	31.7	79.7	15.1	X	0.5	1	Good
*F	39.7	26.1	13.6	33.3	77.6	14.6	VII	8.0	1	Good
*G	37.2	25.5	11.7	31.7	79.3	8.2	VII	8.0	1	Good

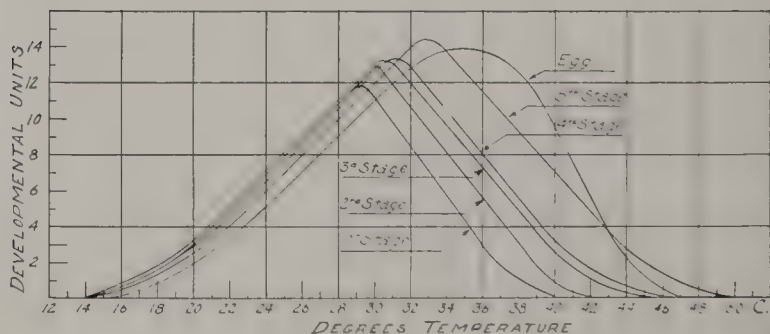


Fig. 2. Curves showing rate of development of the various life history stages at different temperatures along the line of the average daily march indicated by the short oblique lines on Figs. 3-8.

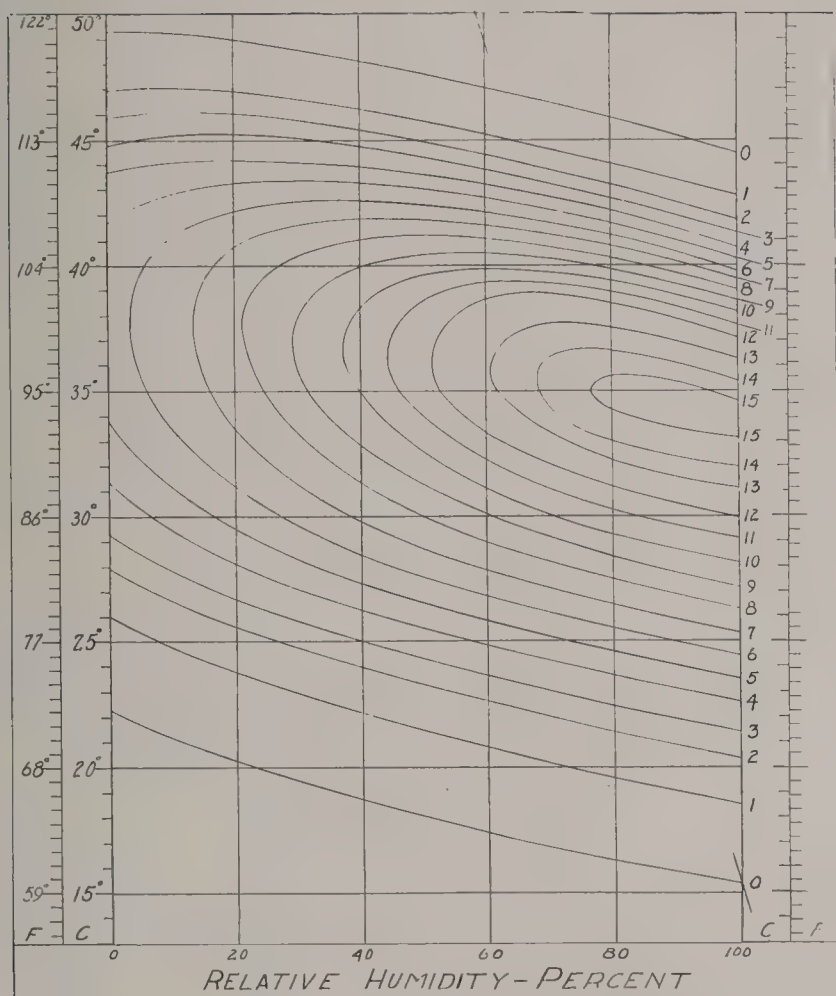


Fig. 3. Provisional chart for the egg stage, based on a developmental total of 1500 Centigrade degree-hour units. Temperature is shown on the vertical scale, humidity on the horizontal. The curved lines represent the same rate of development (in developmental units per hour as shown at the right), based on the same length of time to complete the stage, at the various combinations of temperature and humidity through which the lines pass.

with the codling moth (Shelford, 1927). Temperature is represented on the vertical scale in degrees Centigrade and also Fahrenheit, and relative humidity in percentages on the horizontal scale. The equal-velocity lines have been given an upward slant sufficient to show differences in rate of development at the same temperature and lower humidities, roughly comparable to the averages indicated in column *j*

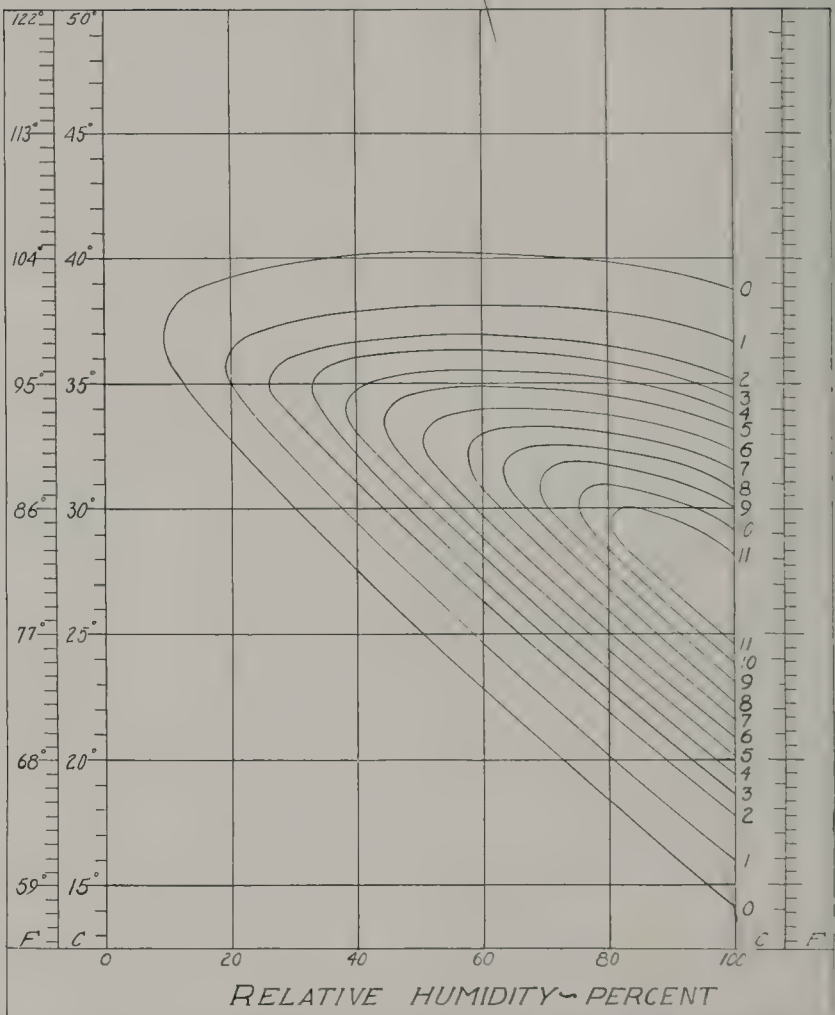


Fig. 4. Provisional chart for the first instar, based on a developmental total of 900 units.

of Tables III and IV. The data are so inadequate, however, that a considerable amount of discretion was necessary on the basis of the experience with the codling moth pupae. Comparison of Figs. 3-8 shows that this difference with humidity apparently becomes less as the insect progresses toward maturity through the various instars. The average percentages were not given full value in the drawing of these charts for two reasons: (1) the insect regulates its surrounding moisture by crawling into cavities and small spaces among the parts of the plant; and (2) a series of experiments referred to above, in which

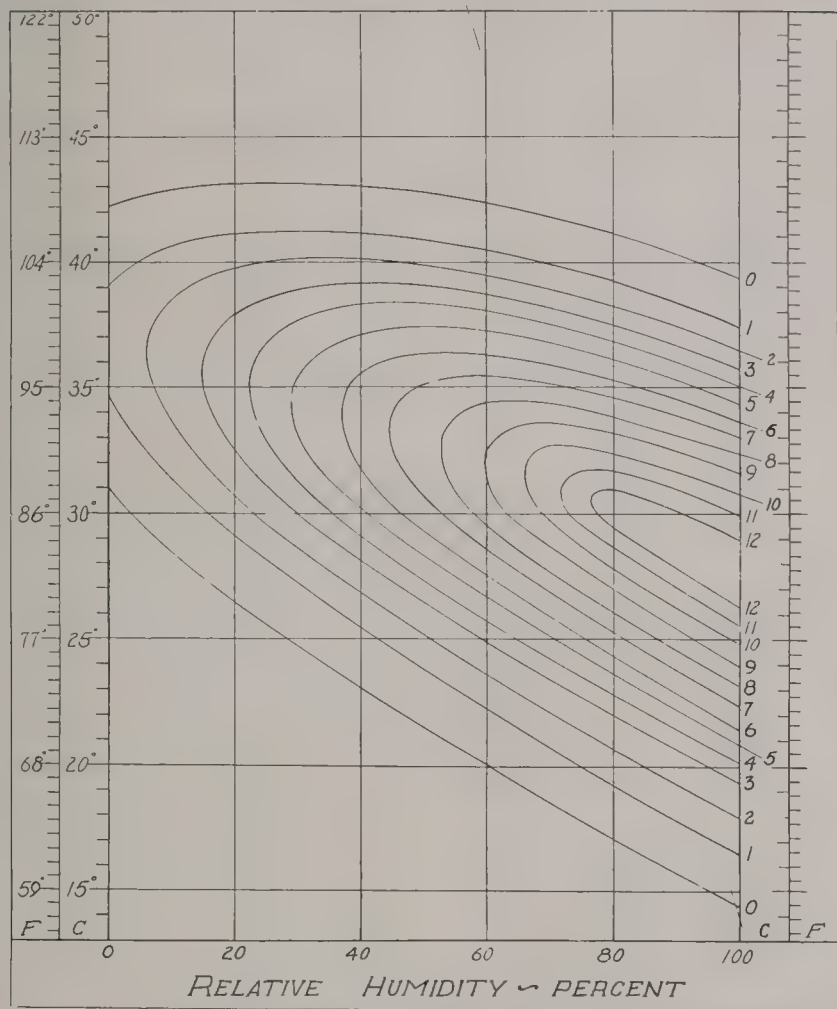


Fig. 5. Provisional chart for the second instar, based on a developmental total of 880 units.

the bugs were fed upon growing plants, indicated less effect of humidity than shown by cut pieces of plant.

The method of reading off the effect of a 10% decrease in humidity from the chart is shown in Fig. 10. X_1 is located on 27°C. and 90% relative humidity and has a velocity value of 10 developmental units per hour. X_2 is located on the same temperature (27°C.) and 80% relative humidity and has a velocity value of 8.5 — a decrease of 15% in rate of development. Again, X_3 , on temperature 21°C. and 90% relative humidity, has a velocity of 3.5; and X_4 , on the same

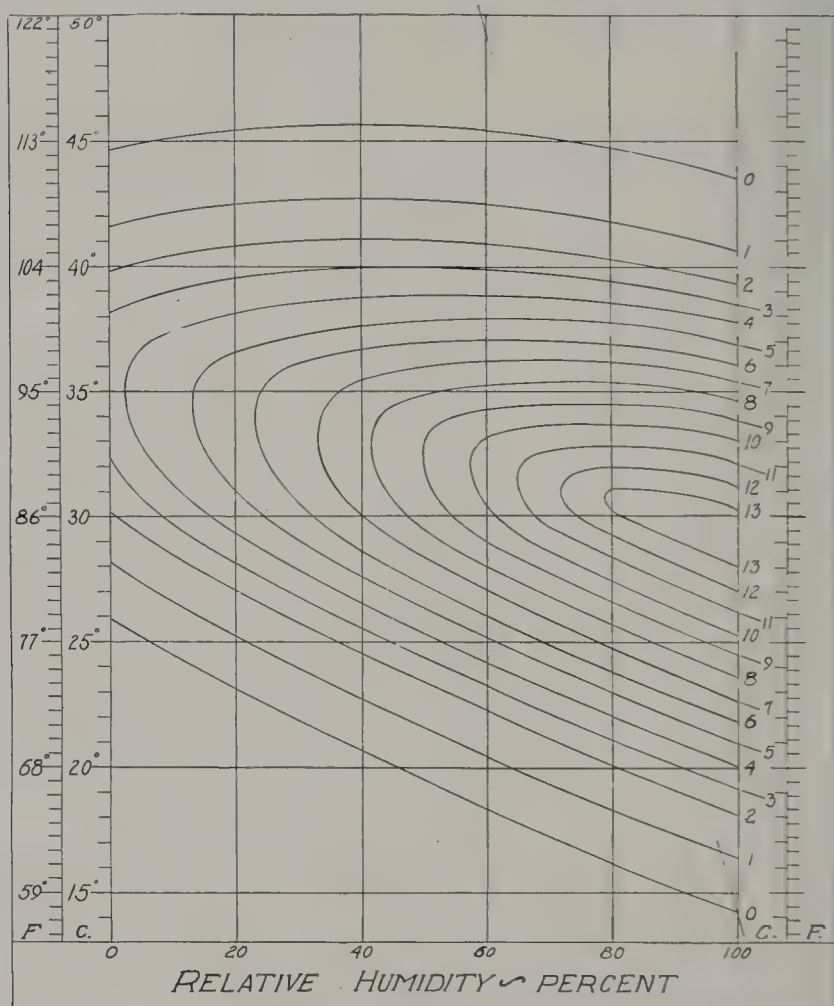


Fig. 6. Provisional chart for the third instar, based on a developmental total of 850 units.

temperature but 10% lower humidity, has a velocity of 2.5. Here the decrease in velocity is $10/35$, or 28.5%. It is noteworthy that the percentage difference in velocity increases as the temperature is lowered.

The curves shown in Fig. 2 are in part a straight line (21° to 29°C.) and represent the rates of development under conditions indicated by the oblique line on Figs. 3-8 which runs from 100% relative humidity and approximately 15°C. to approximately 60% relative humidity and 50°C. but varies somewhat as it is the actual average for each stage. This oblique line thus represents the average daily march

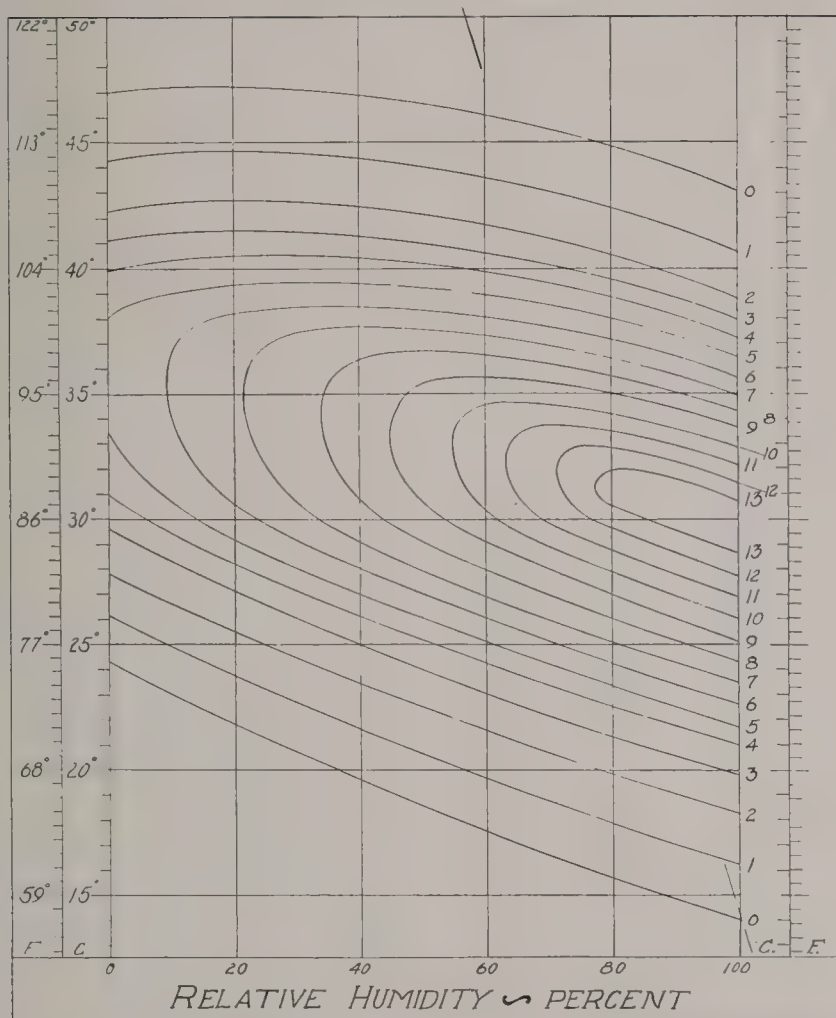


Fig. 7. Provisional chart for the fourth instar, based on a developmental total of 810 units.

of temperature and humidity for the various individuals of the stage in question under the variable-temperature experimental conditions. The development in the egg (Fig. 3) appears to respond less sharply than the various instars (Figs. 4-8).

The velocity values at the various combinations of temperature and humidity were read off these charts (Figs. 3-8) and averaged to give a set of values representing all the life history stages from the laying of the egg to the emergence of the adult, as shown in Table V and Figure 10.

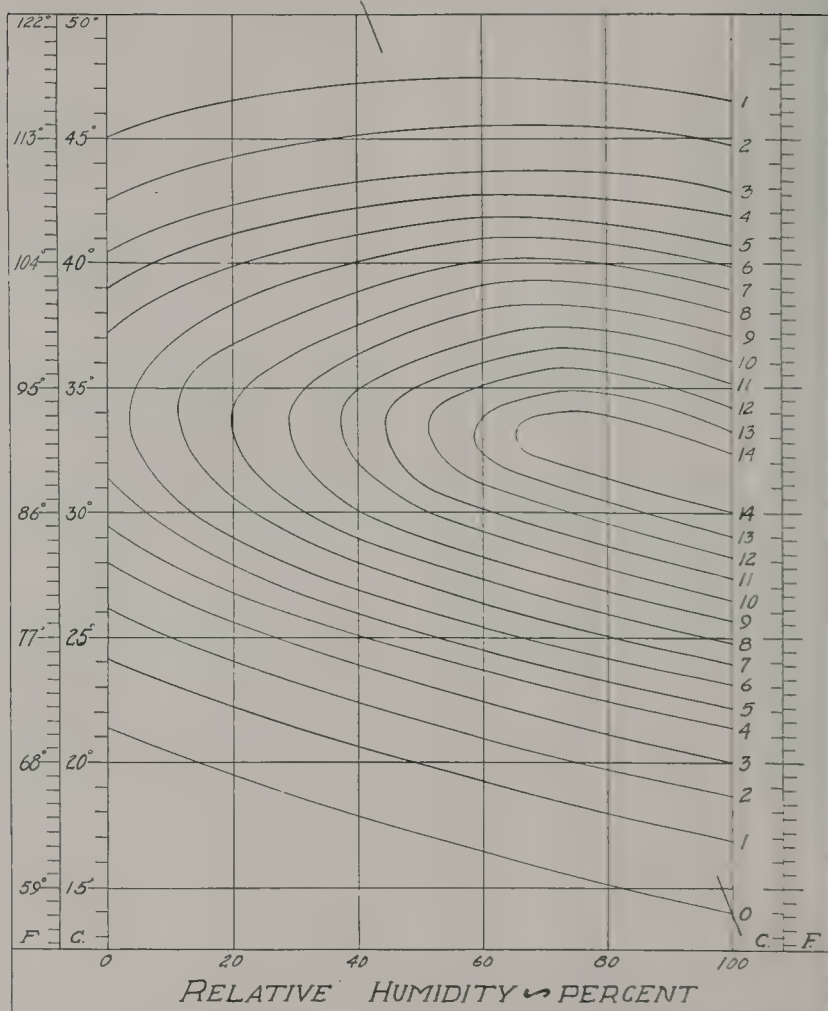


Fig. 8. Provisional chart for the fifth instar, based on a developmental total of 1400 units.

The velocity curve shown in Figure 9 was checked against the values in Table V. This velocity curve is indicated in each of the stages and represents the cross-section of a ridge-like solid on which the equal-velocity lines of Figs. 3-8 would correspond to contours. For a portion of each of these curves the relationship is a straight line (Fig. 2), and within this straight-line portion the product of time and temperature above alpha is a constant (Shelford 1927).

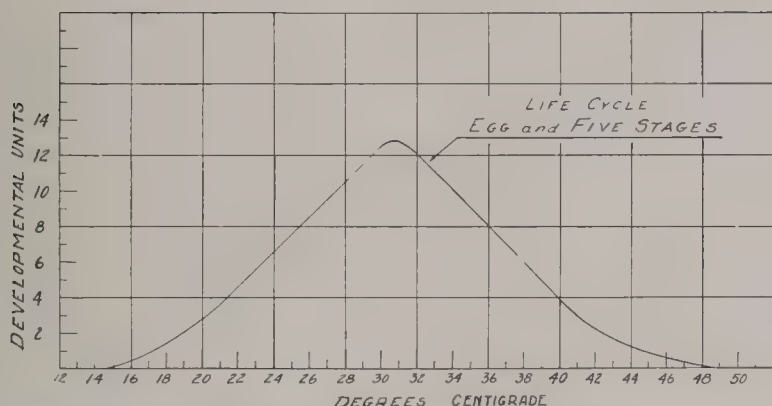


Fig. 9. Curve showing rate of development of the egg and five nymphal stages, based on a developmental total of 6800 units.

Developmental Totals

The developmental total for the life history from egg to adult is 6800 developmental units. Each unit represents the effect of one degree for one hour as indicated by results between 22° and 28°C. These are Centigrade degree-hour units, while Fahrenheit degree-hour units were used in the codling moth work (Shelford, 1927). It has been found in practice that 2-hour intervals are short enough for the purpose; hence 3400 two-hour Centigrade degree units are required for this life history. This figure is for temperature fluctuating 1-7°C.

The developmental total for the egg is 1500 degree-hour units, for the first stage 900, for the second stage 880, for the third stage 850, for the fourth stage 810, and for the fifth stage 1400. The sum of these is 6340, but the variation in values shown in the different charts made 6800 necessary for all stages. The sum of the average lengths of a considerable number of instars which were at approximately the same temperature and humidity was taken as a check upon Table VI. The sum of the time-temperature constants, as determined from the items from which Table VI was made, was found to vary only slightly from the average for each instar.

The pre-oviposition period has been little investigated. It is very long in the hibernating individual and relatively short in spring after emergence from hibernation, when it averages 810 of the egg-to-adult units shown in Table V. This makes the total from egg to egg 7610 units. Because of the small number of cases available in this period, it was not possible to determine the effects of variations in temperature and humidity beyond the suggestion that the effects are similar to those

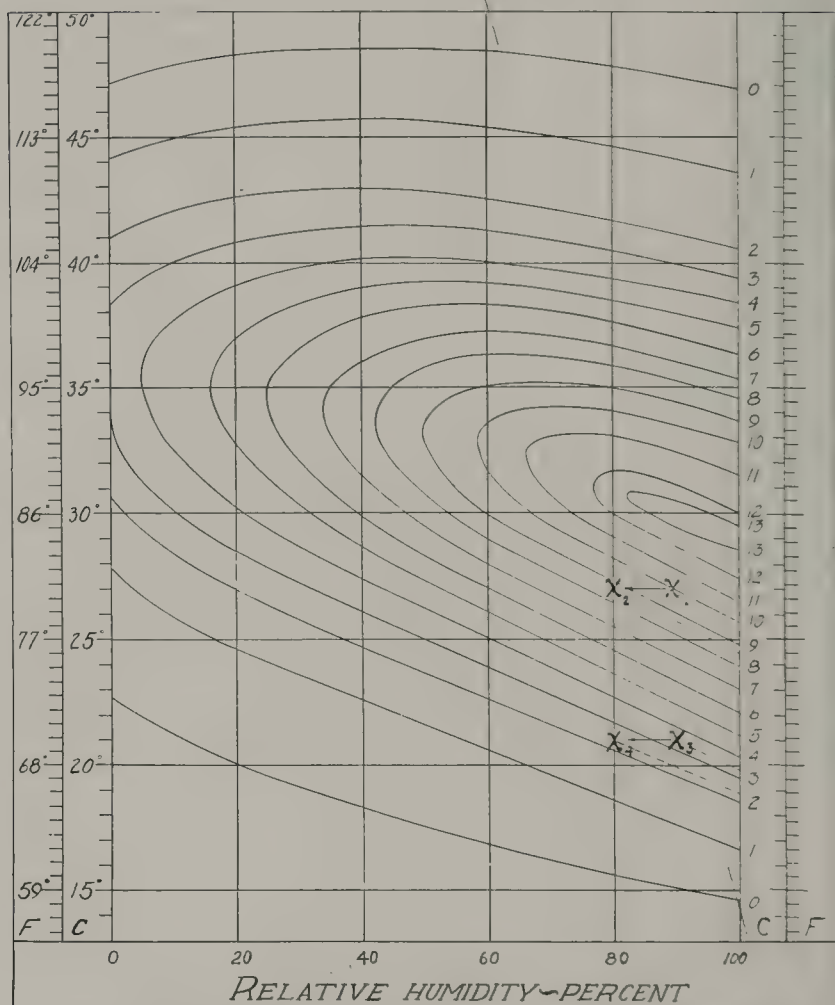


Fig. 10. A composite chart, based on 6800 units as the developmental total for the egg and five nymphal stages. The pre-oviposition period of the adult is not included.

found for the later stages. These separate instar totals for the more variable temperature experiments were checked, however, with tables made from the charts of the various instars. By substitution of the values shown on the charts for the combinations of temperature and humidity (2-hour means), totals averaging close to the figures given were obtained for the more variable temperature. These figures are provisional because there were no outdoor records of instar periods with temperature and humidity data available for checking them.

Overwintering

A considerable number of preliminary experiments with hibernating bugs had indicated that very cold conditions were not necessary; hence, mild moist conditions were mainly tried. In nearly all the years in which cultures were maintained some attempt was made to carry bugs through the winter. In a few cases the bugs were alive in the early spring, but they did not breed.

In 1921-22 an attempt was made to keep the bugs moist and under conditions similar to those out of doors. The temperature was lowered to about freezing in midwinter and then raised to a favorable point in March or April. The bugs were alive in March, but all died under favorable culture conditions.

In the autumn of 1923 the bugs from the several cultures were placed in one culture cage in Chamber A on October 30, and 200 bugs from outdoors were placed in another cage. The temperature was reduced almost to freezing and held there for two months or more and then gradually raised. The humidity was 95%, and grass kept green in the cages. No live bugs were found after March 21.

In the autumn of 1924 the cultures were all placed in the cold chamber, the air was kept very moist (90-95% R. H.) and the temperature lowered to freezing ($0^{\circ}\text{C}.$) by the first of February. Most of the month of February was at, near, or below freezing, with the humidity high. During March the temperature was gradually raised, so that by April 27 the conditions were good for the growth of bugs. It fell to $18^{\circ}\text{C}.$ at night and rose to $27^{\circ}\text{C}.$ during the day. On April 10 the minimum was raised to approximately $20^{\circ}\text{C}.$ On April 23 mating was noted, but no eggs appeared. Two out of three other cultures showed living bugs but no breeding. Each had contained from 15 to 50 bugs in the autumn.

THE CULTURES

The second type of investigation of chinch bugs consisted of setting up cultures under known conditions and observing them from day to day to make records of the growth of the nymphal stages and the number of generations.

In the experiments of 1917-1923, wheat was planted in the containers once or twice a week, depending upon conditions, and allowed to sprout, to supply nourishment for the bugs. Some failures were doubtless due to the deterioration of the food supply, for occasionally the wheat died rather suddenly, without sufficient time for a new supply to grow, especially in the drier experiments. Sudan grass was used in 1924 and 1925, with better results.

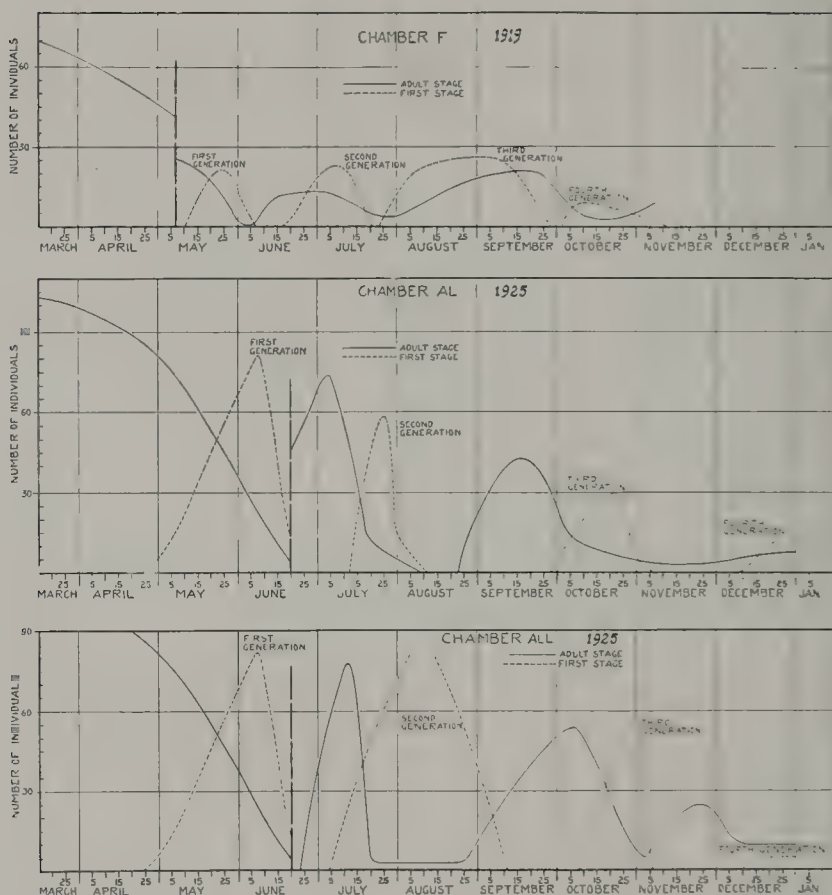


Fig. 11. Curves showing evidence of four generations in cultures in 1919 and 1925.

There are normally two generations of chinch bugs per season, but the number may be increased under favorable conditions. In Fig. 11, which shows the histories of selected cultures grown in 1919 and 1925, with the date of starting and the number of individuals present in each, there appears some evidence of a fourth generation in 1919, although there was no interim when young stages were not present in some numbers in that instance. In 1925 the nymphs that were brought in from the field were put into the experimental cages (chambers AL and ALL) on June 20. Nearly all these nymphs had then progressed to fourth and fifth stages, although a few still remained in the first stage. Thus the majority of them in chamber ALL transformed into

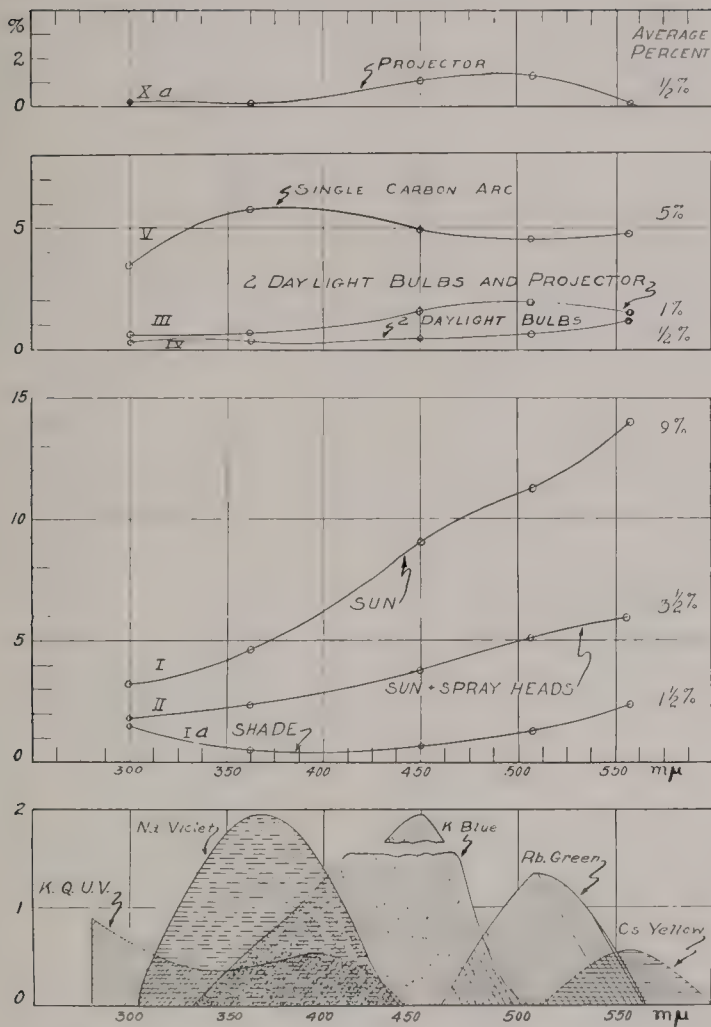


Fig. 12. Curves showing the midday light conditions in the experimental chambers (especially units A and B), indicated in percentage of the midday sunlight of clear days in early July. The measurements were made with screened photo-electric cells with the wave-length sensitivity shown below by the shaded polygons. The Roman numerals on the curves are used in Figs. 14-24 and in Table VII to designate the curves in their relations to particular experiments.

adults by the tenth of July. First-stage nymphs of the second generation then appeared in the culture, and the adults practically disappeared by July 20. Incidentally, the sex of those remaining was not determined, but the presence of males is to be expected and they would not

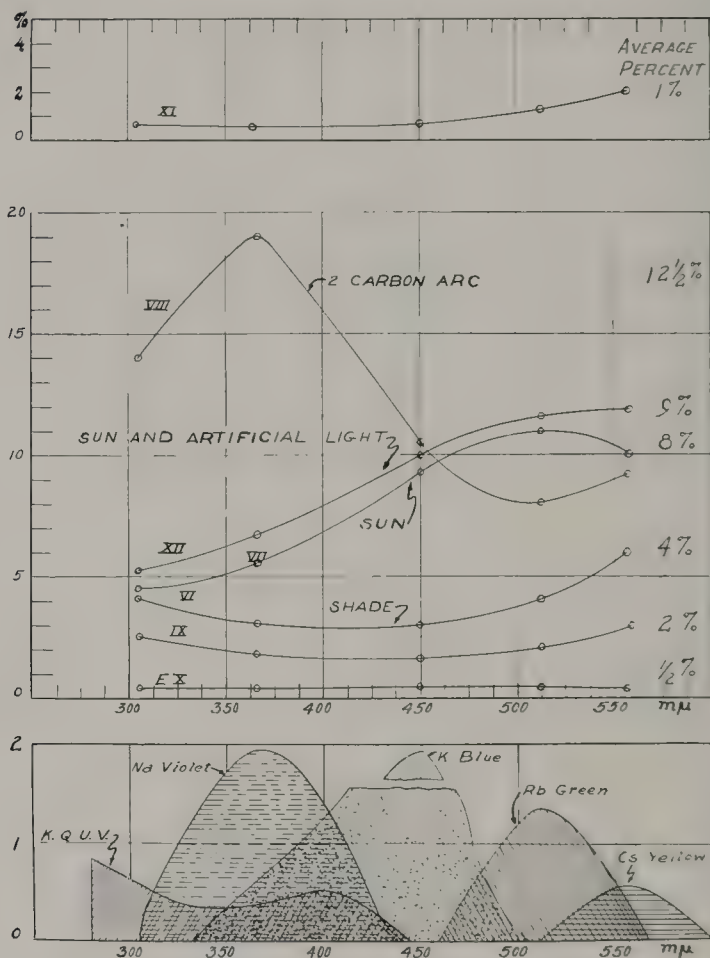


Fig. 13. Similar to Fig. 12 but with particular reference to units C, D, E, F, and G, which were small and had water tanks above and side-walls of double glass.

necessarily participate in subsequent generations as females would. By the end of August the adults began to increase again, through additions from the nymphal stages, and reached a maximum on October 5, almost at the same time that the third lot of first-stage nymphs began to appear. These nymphs reached their maximum number at the end of October and had all disappeared by November 5. The number of adults rose from a minimum at that time to a final maximum about November 25, and their decline in December was followed by the appearance of first-stage nymphs of the fourth generation. The culture in chamber AL

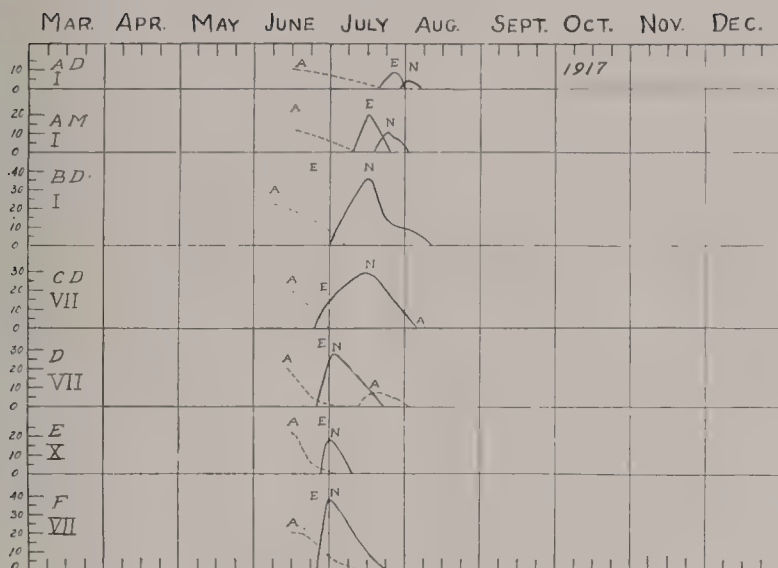


Fig. 14. Curves showing the numbers of chinch bugs placed in the cultures, and their success in breeding, in 1917. A = adults, shown by broken lines. N = nymphs, shown by solid lines. E = eggs. M = mating. Scale at left indicates numbers of individuals. The letters indicate the experimental chambers and the Roman numerals the light intensity, as shown by curves in Figs. 12 and 13. For temperature and humidity see Table VII.

had a similar history but with a somewhat shorter halt between the second and third generations. These data may not be taken as demonstrating beyond any doubt that four generations of bugs occurred. Since the primary purposes of the experiments were to observe the success of general cultures under different conditions and to provide individuals for the determination of the length of instar periods, not all of the adults were removed at the close of each egg-laying period, so that allowance must be made for the bare possibility that some of the individuals recorded as instars were rejuvenated adults. However, it is a noteworthy fact that these evidences of a fourth generation occurred in both cases with the general breeding vigor of the bugs at its highest.

Vigor of Stock

Great differences in the hardiness and fecundity of the stock are indicated by the differences in the success of the cultures shown in Figs. 14-25. In 1919 the bugs were apparently more vigorous than in 1917 and 1918, but their vigor declined in 1920 and reached a minimum in 1921, when all the experiments were started with new stock at least

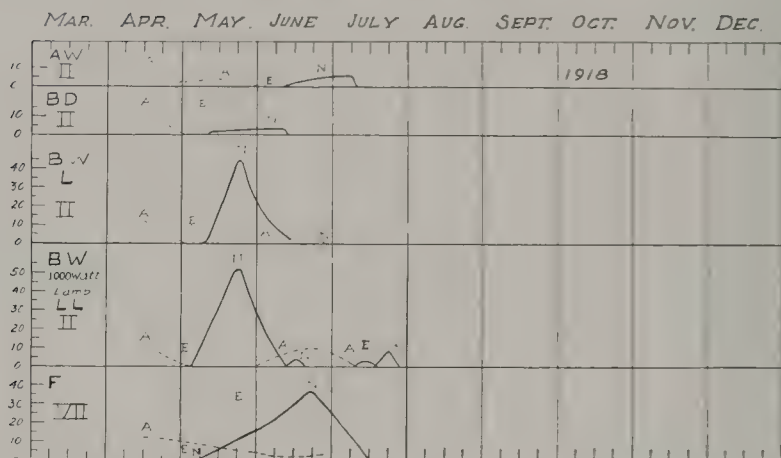


Fig. 15. Curves showing success of all cultures in 1918. For explanation see Fig. 14.

three times without success. The vigor of the bugs then rose from the minimum in 1921 to the maximum in 1925. In each year the experimental stock was obtained from the nearest infested fields, and in no case was the distance from the point of experimentation more than a hundred miles. Stock used in the first year came from Sangamon and Macon counties, where in 1917 and 1918 only slight damage was done. By the end of 1918, however, the bugs increased very greatly over the whole southern and eastern portion of the state, though they failed to do much damage in 1919 on account of unfavorable weather in the spring. The stock used in 1919 came from Christian County. In 1920, 1921, and 1922 the stocks were secured locally (Champaign County), where very slight damage occurred. In 1923 the bugs did considerable damage over a large part of Illinois, and the stocks were taken locally in that year and also in 1924. In 1925 they came from the only area which showed a severe damage to crops, near Stonington, Christian County. It is necessary to assume either that a rhythm of vigor is hereditary in the species or that the weather conditions of autumn and winter (and perhaps also of early spring determine the vigor of the stock (through food or otherwise) as a physiological process. It is possible that the breeding vigor increases as the season advances, for it was repeatedly noted that the bugs brought in late in the season bred more successfully than those taken early.

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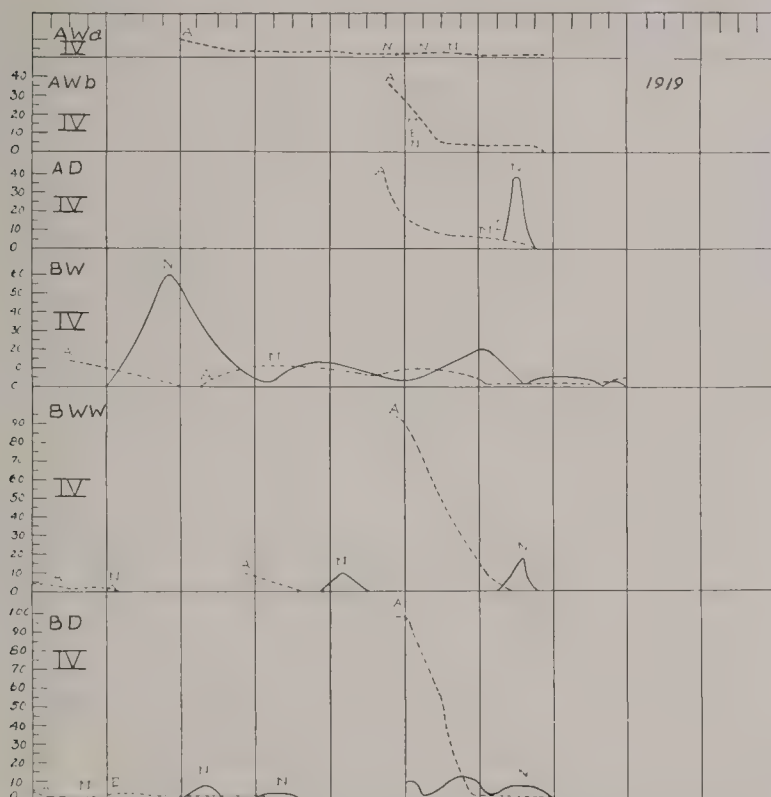


Fig. 16. Curves showing success of six cultures, AWa, AWb, AD, BW, BWw, and BD, in 1919. For explanation see Fig. 14.

Effect of Light

The behavior of organisms may be affected by the quality (wave-length) as well as the intensity of light and by variability of either its intensity or its quality. Various wave-lengths have been found recently to have specific effects upon certain organisms. Some of these specific effects have been found in extra-climatic rays, that is, those wave-lengths outside the limits of the sun's spectrum. The sun's ultra-violet diminishes to zero intensity at approximately 290 millimicrons. It is in the invisible light that most of the effects upon organisms are supposed to be found, largely because of the noteworthy effects upon rickets and the development of vitamins in cow's milk, etc. It is true also that other wave-lengths, particularly some of the invisible heat waves, have specific effects. Furthermore it is well known

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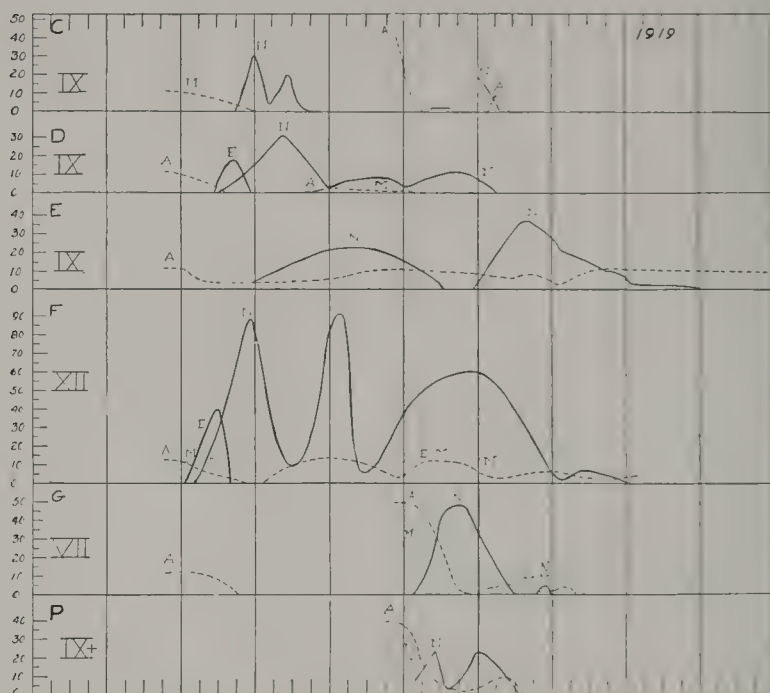


Fig. 17. Curves showing success of six cultures, C, D, E, F, G, and P, in 1919. For explanation see Fig. 14.

that various wave-lengths in the visible spectrum have different effects upon animals and upon certain insects, as shown by their size and success so far as survival and reproduction are concerned.

Unfortunately, window glass does not transmit wave-lengths shorter than 320 millimicrons, and when the sunlight must pass through three thicknesses of glass as in all containers in these experiments, most of the short wave-lengths are eliminated, especially those known to be effective in influencing organisms. The newer kinds of glass transmitting short wave-lengths were not put on the market until near the close of these experiments. Fused quartz, which transmits all wave-lengths practically without selection, was available only in very small pieces and at too great cost. Unfortunately, the conditions under which the experiments were carried on were such as to reduce the intensity of light very greatly. The greenhouse roof was found to transmit only 10 to 60% of the sunlight, and this of course with the short wave-lengths eliminated. The experimental chambers

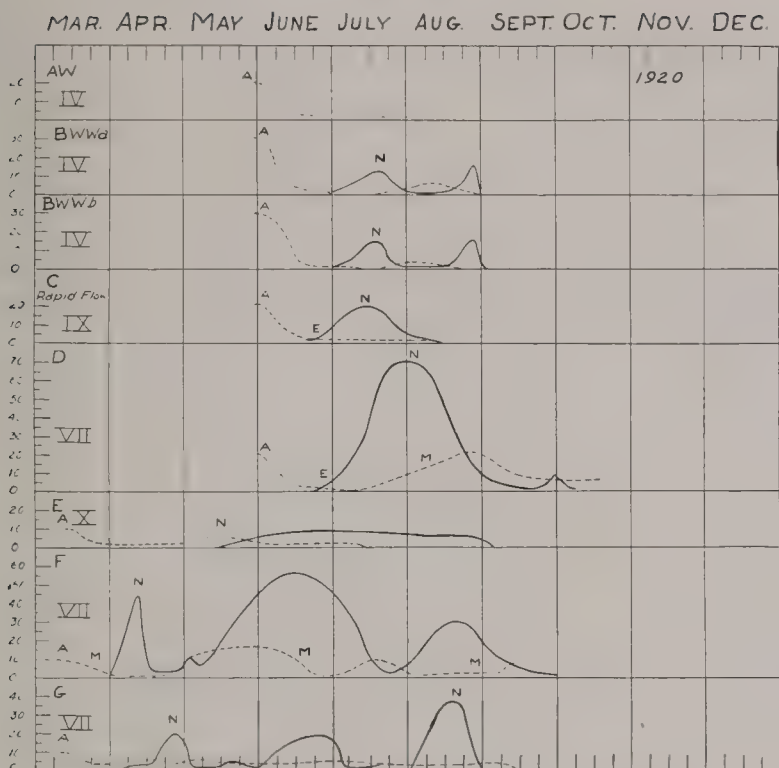


Fig. 18. Curves showing success of all cultures in 1920. For explanation see Fig. 14.

were supplied with double and triple window-glass sides and roofs. The containers themselves had window-glass sides and tops. Thus there were at least three and even four thicknesses of glass between the sun and the chinch bugs. This reduced the light to 10% or less, depending upon the hour of the day and other conditions. In addition, the framework of the greenhouse roof, of the constant-temperature chambers, and of the glass-sided culture cages, all cast shadows from time to time over the food plants and the insects under experimentation.

In this connection mention should be made of the difficulty of maintaining constant or nearly constant temperature in a greenhouse which goes to 13 or 15°C., especially when it is taken into account that a closed chamber exposed to the sun inside such a greenhouse would go to 55°C. or more if uncooled and without air circulating through it. In order to maintain temperatures at points between 20 and 30°C. it is necessary, therefore, not only to circulate the air in the chambers but also to provide some method of cooling. The efficiency of the

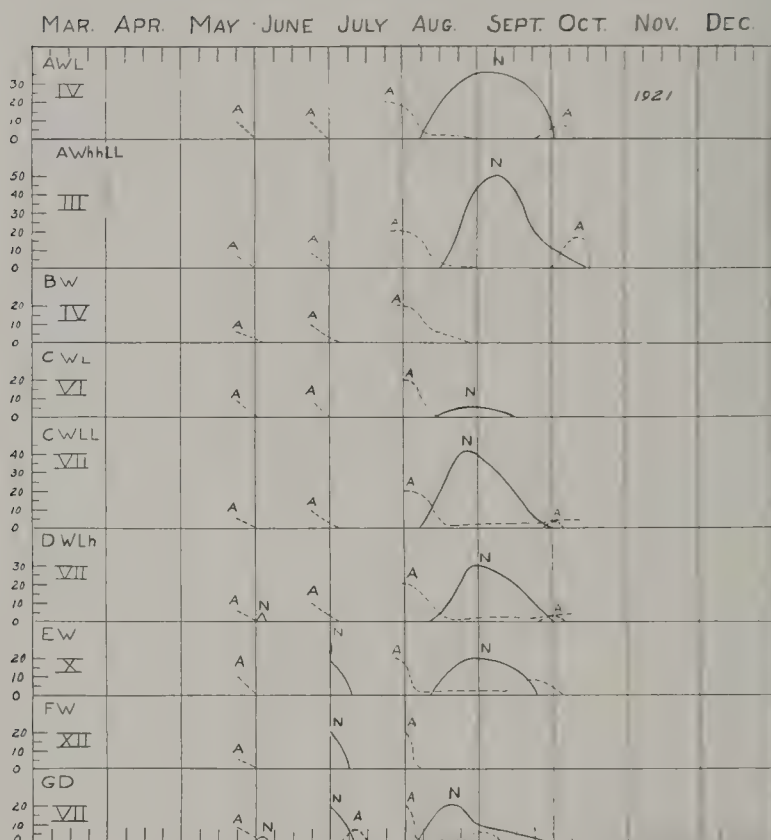


Fig. 19. Curves showing success of all cultures in 1921. For explanation see Fig. 14.

apparatus available, while supposedly adequate, was so low as to necessitate the addition of spray-heads to cool the glass sides and in some cases the tops of the units. This reduced the light intensity very materially, through reflection and partly by the dirtying of the glass with iron from the well water used. The tops of the variable-temperature chambers were provided with water tanks made of glass, with automatic controls so that more water flowed through the tanks when the temperature was high. The light was thus filtered through water two or three inches deep, and the accumulation of iron on the bottoms of these tanks resulted in a still further decrease of the transmitted light, in spite of cleaning two or three times daily. It is apparent, therefore, that the apparatus available, either on the market or installed at the time these experiments were begun, was altogether inadequate for the control of light.

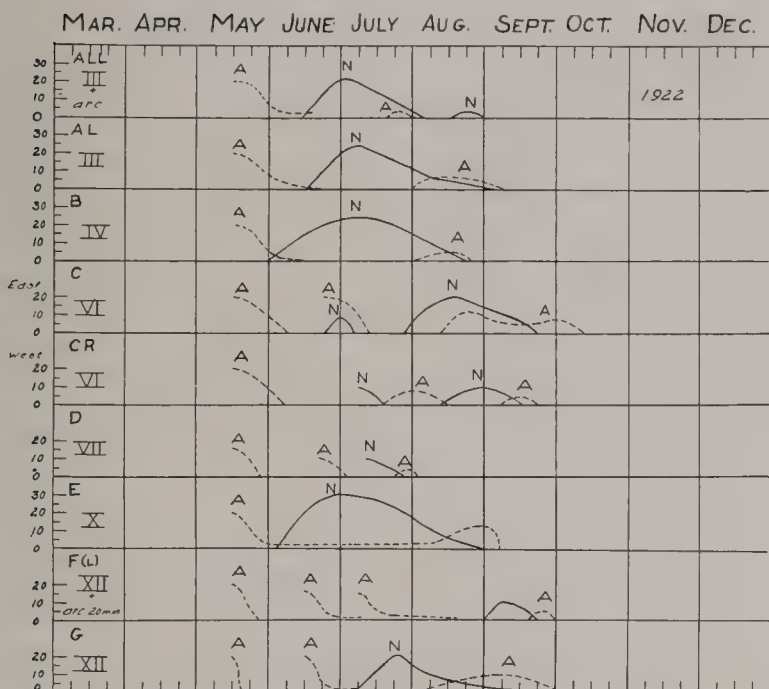


Fig. 20. Curves showing success of all cultures in 1922. For explanation see Fig. 14. In culture ALL, the white flaming arc was applied for a period which was increased from 10 to 30 minutes as the days shortened after June 21. In culture CR the flow of air was rapid and the evaporation high.

Artificial light was supplied from nitrogen-filled, clear-glass and "day-light" lamps and by white flaming arc lamps, such as are used in making motion pictures. On account of the large amount of heat produced by the nitrogen-filled lamps it was impracticable to install any but those with relatively low wattage inside the chambers with controlled temperature. When any of these lights were installed outside the chambers, the light reaching the cultures was greatly reduced by the three or four thicknesses of window-glass which intervened.

Unfortunately, when the experiments were being planned, no method of measuring the quality and quantity of light was at hand. It was not until the close of the experimental work that methods were developed to a point where they could be utilized. Accordingly, the amount of artificial light supplied in the form of Mazda lamps was far smaller than would otherwise have been selected. The instruments used in measuring light were the photo-electric cell and the Macbeth illuminometer, which was used a little beginning in 1922. Previous to that time no measurements were made.

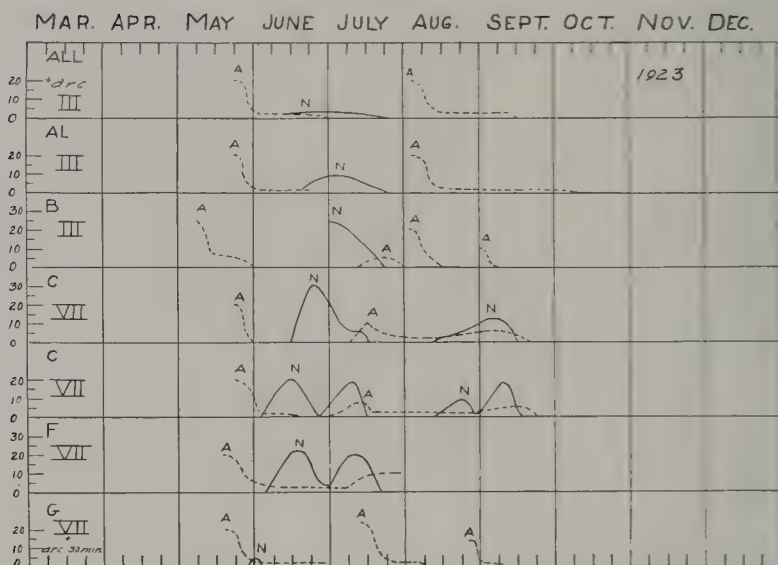


Fig. 21. Curves showing success of all cultures in 1923. For explanation see Fig. 14. The arc was applied to culture ALL 5 minutes per day and to culture G 30 minutes per day.

After the close of the experiments, however, the entire series of illumination types were checked over with a set of photo-electric cells made by Professor Jakob Kunz of the Department of Physics. The development of these cells involved a large amount of investigation, an account of which has been published elsewhere, and in the end the forms of the cells were such that only a type developed after the experiments were finished could have been used to record light continuously within the experiments. This is due to the fact that the ordinary type cell has an area of sensitive surface and an aperture similar to that of the eye, that is, a circular aperture, opening to a hollow sphere sensitive on the inside. The cell which might be used for recording of light intensity in biological work has a fully exposed hemispherical convex surface. Cells of the concave type mentioned above were placed so as to face the sun in connection with an apparatus which turned on artificial lights shining on the experiments whenever the sun was obscured by a cloud. The measurements made with the photo-electric cells were continued with the cells covered with ray-filters of colored glass—red, yellow, green, blue, violet, and ultra-violet—each of which transmits principally the colors named. Finally, in the early part of July, 1925, series of measurements were made on clear days to

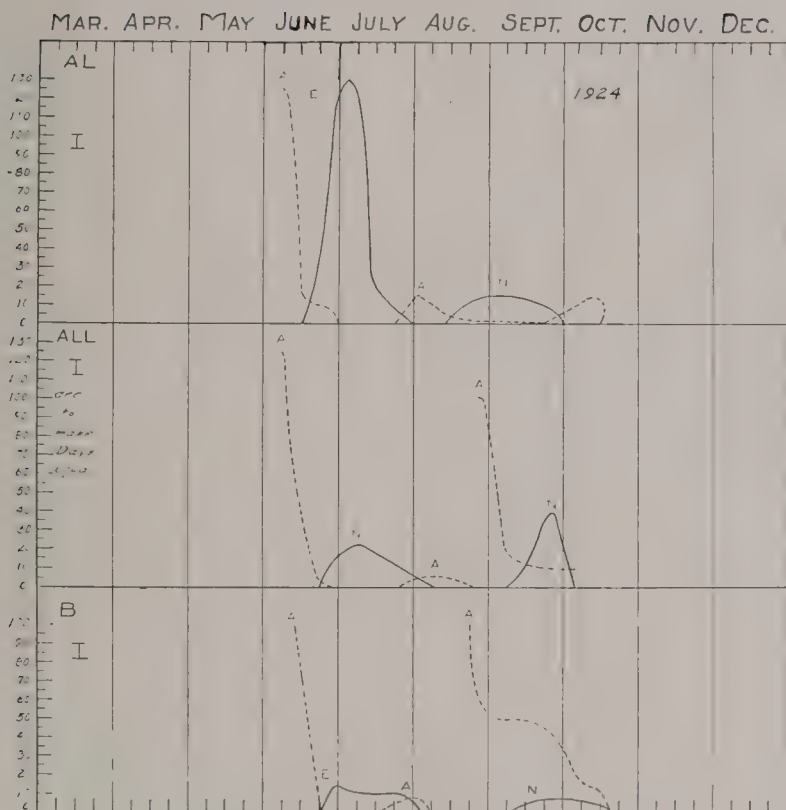


Fig. 22. Curves showing success of three cultures, AL, ALL, and B, in 1924. For explanation see Fig. 14. The arc was applied to culture ALL long enough to make days equal and to culture F 30 minutes per day.

compare the intensity of sunlight with the light passing through the greenhouse roof and the walls of the various chambers and cages in which the chinch bugs had been reared.

The light conditions thus determined for the different experiments are shown in Figs. 12 and 13, and the results obtained with cultures under these conditions are shown in Table VII. The amount of light is expressed in the table as the percentage of noon sunlight in early July. The percentages given are the percentages at noon. It must be understood that the light declines much more rapidly in the afternoon and increases much more slowly in the morning in these enclosures than in the open. In Figs. 12 and 13 a correction has to be made for the graphs indicating fairly high intensity of light at 305 millimicrons because, as shown in the lower graph, while this is the highest point

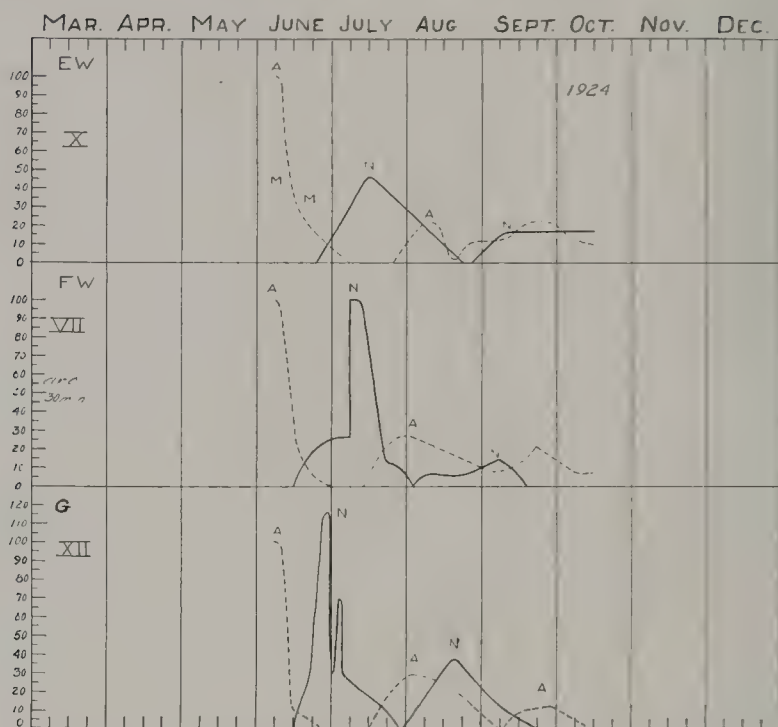


Fig. 23. Curves showing success of three cultures, EW, FW, and G, in 1924. For explanation see Fig. 14. The arc was applied to culture ALL to make days equal.

in the curve the sensitivity of the cell and screen reaches to 425 and the second maximum at 400. The sodium cell of the "ultra-glass" probably measured practically all the light indicated. The white flaming arc, which was used in A wherever noted, is particularly intense in the violet, the proportion being in excess of that of daylight.

The light conditions appear to have had relatively little effect upon the chinch bugs; that is, the difference between the results at 8% and at 9.5%, as indicated by the experiments in 1917 (Fig. 14), is as great as the difference between the results at 12% and at 0.5%. Again, in 1918 in culture BWL (Fig. 15), 3% was less successful than 5%. Further, in 1919 (Figs. 16 and 17), 0.5% in culture BWW was almost as successful as 9% in culture F. The temperatures in the latter were doubtless more favorable. In 1920 (Fig. 18) bugs in F were somewhat more successful in maintaining a population than those in G, and the day was longer in F than in G. In 1921 (Fig. 19) there is only a slight difference between 0.5% and 1% in chamber A. The bugs in

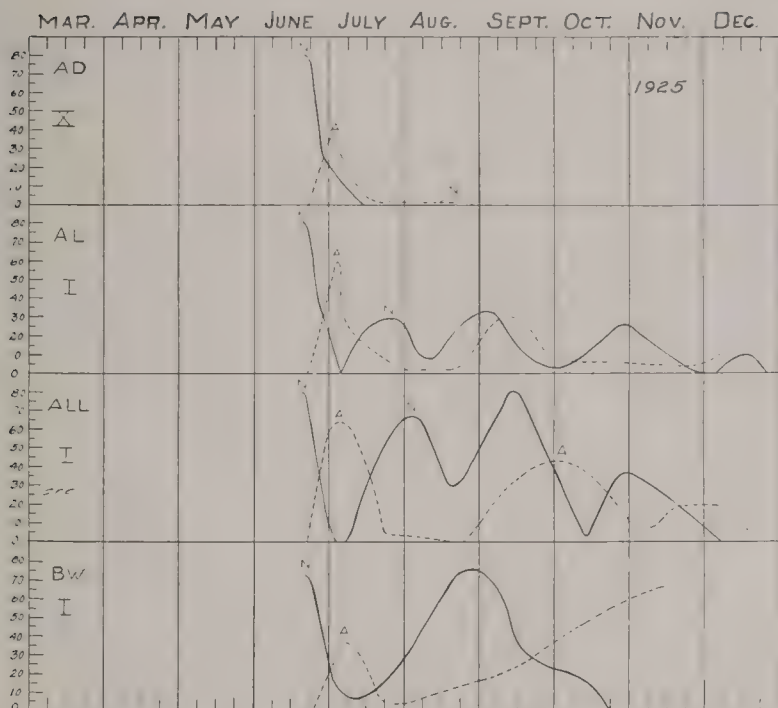


Fig. 24. Curves showing success of four cultures, AD, AL, ALL, and BW, in 1925. For explanation see Fig. 14.

chamber C flourished better under the stronger light. The results in 1922 (Fig. 20) indicate that the bugs in A were favored in one case by an extended day produced by the white flaming arc, but in F and G the results were better with less light. In 1923 (Fig. 21) the two identical cases flourished best without the use of the arc in A, while in F and G the arc appears to have favored the development of the bugs. In 1924 (Fig. 22) the results in A with the use of the arc were not as good as without it. The same is essentially true in F and G. In 1925 all cultures were unusually successful, there being little difference between those in which the arc was used and those in which it was not used, and the light which was turned on automatically when the sun went under clouds appeared to have little effect. All cultures in this year were especially vigorous, as was the case also in 1919. Sudan grass, which was utilized for food in 1924 and 1925, is probably better for such experiments than is wheat, which was used in earlier years; but a comparison of the results in 1919 and 1925 with those of other years indicates that apparently the vigor of the bugs is an outstanding cause of the differences in success.

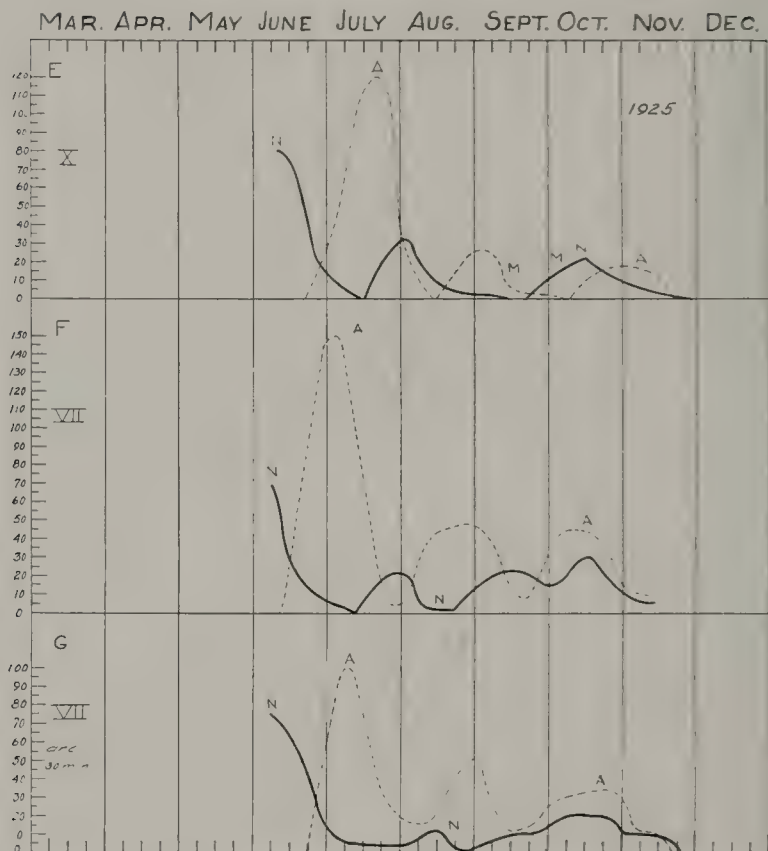


Fig. 25. Curves showing success of three cultures, E, F, and G, in 1925. For explanation see Fig. 14.

In container E, which was run every year with about 0.4% of noon sunlight at noon, the cultures showed a better development, with one or two exceptions, than some of the other cages with much more light. It stands out strikingly in every year. In 1919 (Fig. 16) the E culture was somewhat slower, but nearly as good as the F culture. In 1920 (Fig. 18) the E culture made as much development as some of the lighted cultures. In 1921 it held its own fairly well, and in 1922 (Fig. 20) it was one of the most successful of the cultures. A, B, C, and E were the only cultures which did not have to be started two or more times in 1922 due to failure. Culture E, although provision for which was accidentally omitted from Fig. 21, in 1923 made as good a showing as F of the figure.

All of these facts seem to indicate that intensity of light is not a very important direct or indirect factor within the limits tested in these

experiments. It is true that very little of the light of shorter wavelengths could pass through the three or four thicknesses of window-glass covered at all times with dust and dirt which unavoidably accumulated.

An examination of Table VII and the culture graphs in Figs. 14-25 shows no consistency as regards the effect of light and only a little as regards other factors. Usually the addition of more light gave a little better culture. Usually the higher humidity gave best results, but the results on the whole are inconsistent. This is probably due to differences in the food plants, the occasional growth of other insects in the cultures, etc.

ABUNDANCE IN NATURE

The distribution area of chinch bugs includes the eastern half of the United States, and the area in which they do greatest damage to crops is in the central part of the Mississippi Valley. There are records of occurrences of single and scattered bugs in Mexico and Central America and in the western parts of the United States and occasionally in southern Canada.

History in Illinois

The records of chinch bug outbreaks in Illinois date back to 1840, when there was slight damage to crops in the western part of the state. There was some damage near Springfield, in the central part, in 1844, and in the west-central and northeastern parts in the following four years, 1845-1848. The next period for which the records indicate considerable damage covered seven years, 1853-1859. Another outbreak started in 1861 in the northern part of the state and covered several localities in 1862, one of which was in the extreme north and another in the extreme south. Several outbreaks occurred in 1864 and 1865, but the state remained free from complaints of damage during the next five years. In 1871 there was a severe outbreak covering all the north-central portion, and this was followed by damage over practically all the state for three succeeding years, 1873-1875. The chinch bugs then practically disappeared for five years but suddenly came forward in great numbers in 1881 and 1882. After another decline they began again to do heavy damage in the southern half of the state in 1885, and by 1888 the whole state was subject to extreme damage, but the bugs were very scarce in 1889 and 1890. Except for moderate outbreaks in 1891 and 1894, they were on the decline for a decade and remained at very low ebb for another decade. The next important outbreak had its beginning in 1909 and lasted until 1919, persisting

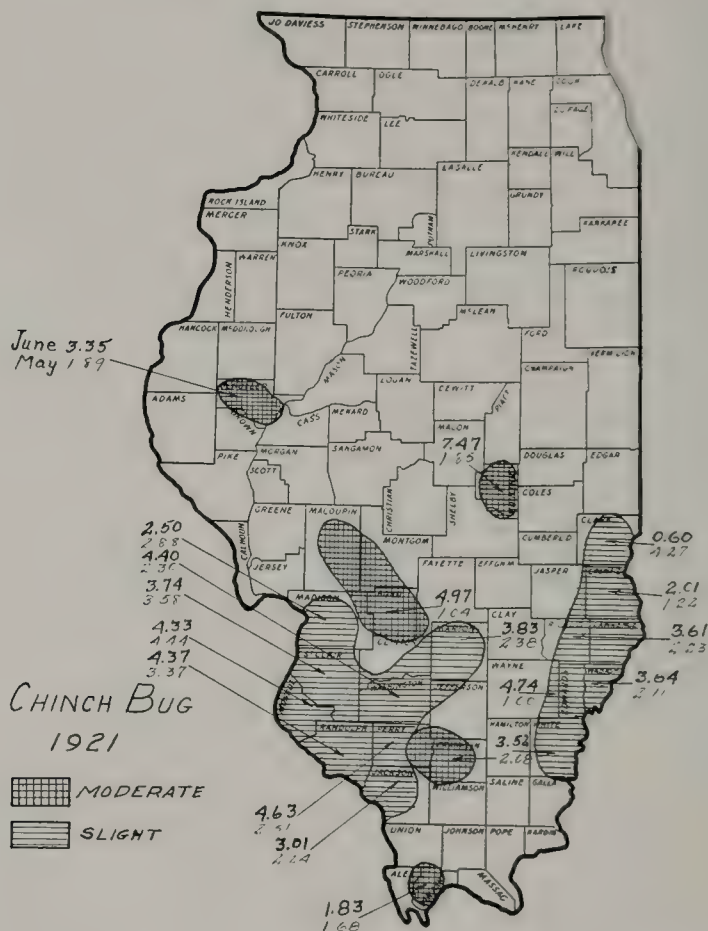


Fig. 26. Map of Illinois showing reported areas of damage to crops by chinch bugs in 1921, together with inches of rainfall in May (lower figures) and in June (upper figures) in each locality.

through this entire period in Washington County and the adjacent areas. The areas of infestation shifted considerably in 1920 and gradually spread for four years in patch-work fashion over the state. During most of this period Christian County was the center of devastating outbreaks. The chinch bugs declined in 1925, and while they did some damage in 1927 they continued to decline to a minimum in 1929. This was followed by a very material increase during the summer of 1930, though it came too late in the season to do any damage to crops.

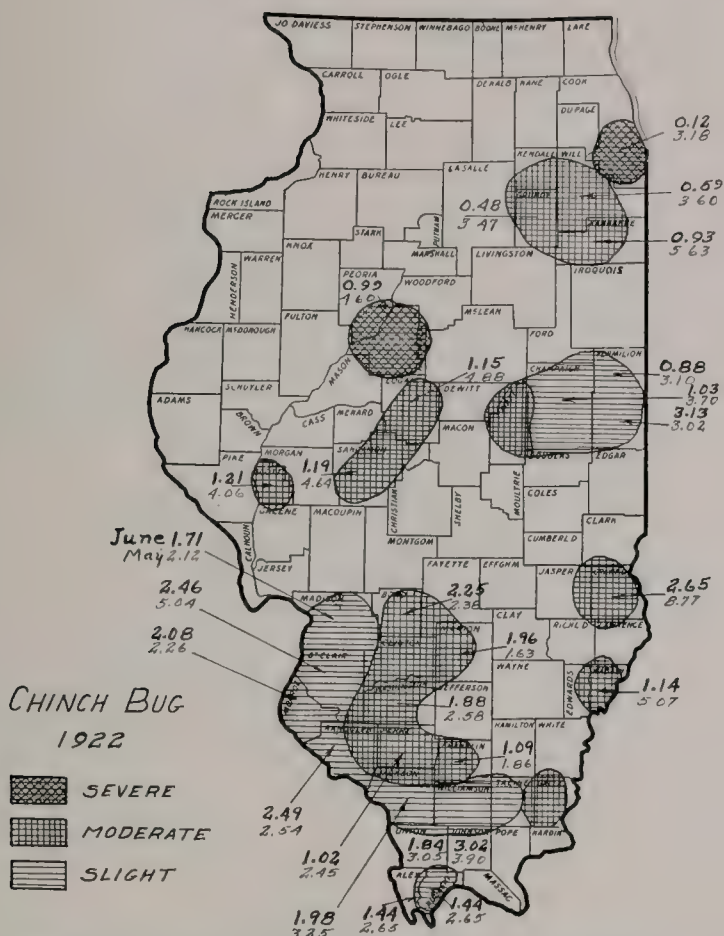


Fig. 27. Map of Illinois showing reported areas of damage to crops by chinch bugs in 1922, together with inches of rainfall in May (lower figures) and in June (upper figures) in each locality.

Figs. 26-30 show the distribution of infested areas from 1921 to 1925. The erratic shifting of the areas of abundance from year to year is characteristic and has to be explained on the basis of favorable weather and either the perennial presence of the bugs or their flight from infested areas. In the southern half of the state the former is the more likely explanation.

Weather Relations

The fluctuations in abundance of chinch bugs have long been associated with weather conditions. The early writers refer to late spring rains as causing the destruction of the bugs. It was pointed out

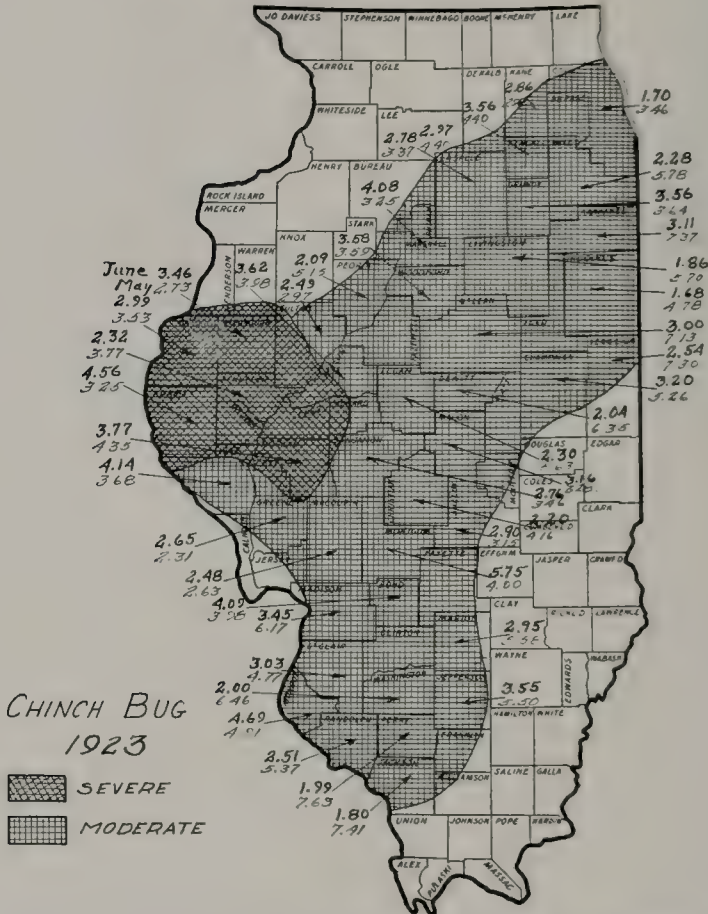


Fig. 28. Map of Illinois showing reported areas of damage to crops by chinch bugs in 1923, together with inches of rainfall in May (lower figures) and in June (upper figures) in each locality.

by Thomas (1879) that a dry May and June and two dry summers are essential to the development of excessive numbers of these pests. Though they are apparently absent from large areas in spring, the small numbers which are present in a given area may develop rapidly if the season is very favorable and may increase to enormous numbers by autumn, and enough of them may survive the winter to build up a population that will do a great deal of damage in the following year even if the weather then is adverse. The variation in vitality and fecundity referred to above is, however, a subject for the most careful investigation from a physiological viewpoint. Their decline is probably

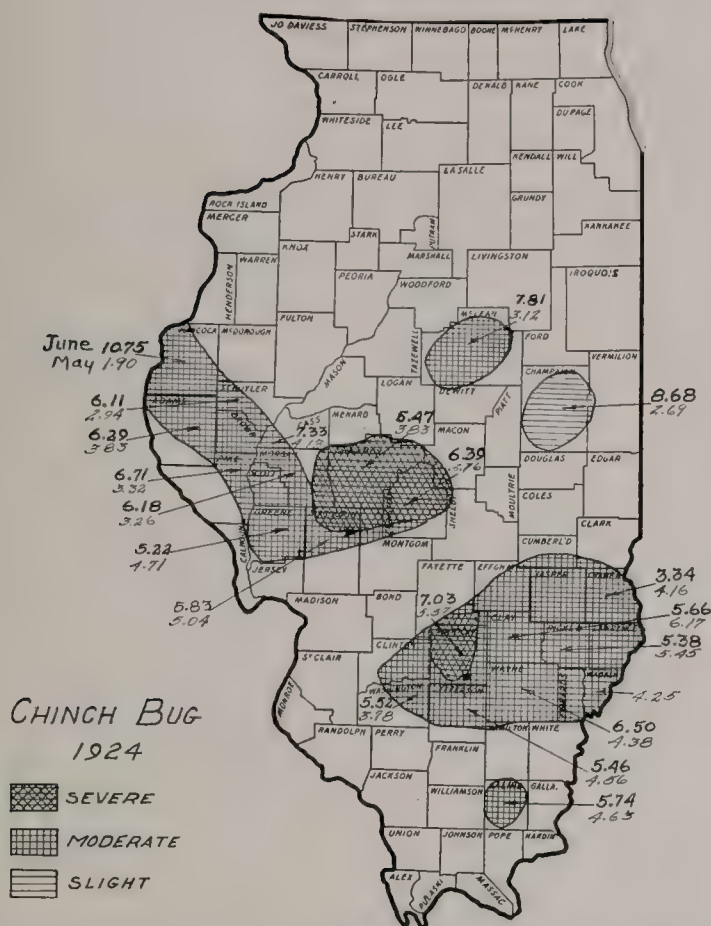


Fig. 29. Map of Illinois showing reported areas of damage to crops by chinch bugs in 1924, together with inches of rainfall in May (lower figures) and in June (upper figures) in each locality.

less closely correlated with external conditions than is their rise to abundance, but both are not so simple as was commonly supposed in the past. In some years the bugs practically disappear from most localities in Illinois, so that specimens can hardly be found. In the last 20 years the only area in which it has been possible to find bugs at all times is an area in the southwestern part of the state, east of St. Louis, reaching into the western half of Marion County and Fayette County, the southern half of Christian County, and the northern half of Washington County.

The importance of late spring rainfall has been confirmed by the writer's examination of weather records for localities in Illinois and

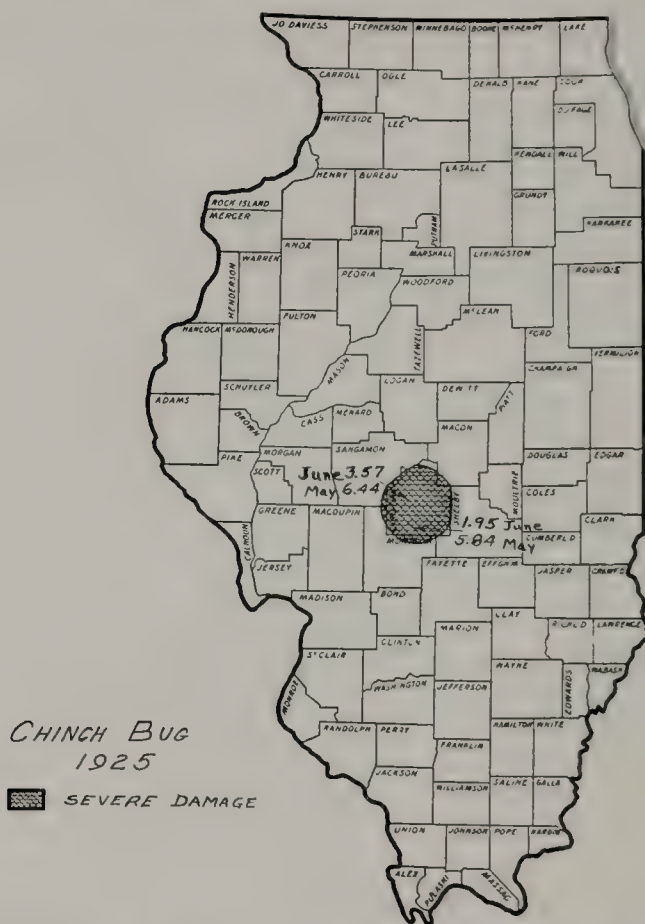


Fig. 30. Map of Illinois showing reported area of damage to crops by chinch bugs in 1925, together with inches of rainfall in May (lower figures) and in June (upper figures).

elsewhere. An exhaustive study was made of the data for periods of abundance and scarcity of bugs as indicated by reports of damage to crops in various parts of the state since 1853. Special analysis was given to a very large number of cases in which a year of severe damage was followed by a year of no damage, and to an almost equally large number of cases in which the reverse was true. In each case a hythergraph was made, according to the plan used in the study of the codling moth (Shelford, 1927), by plotting the mean temperature against the mean rainfall for each month of the year. The results are summarized in Figs. 31-34.

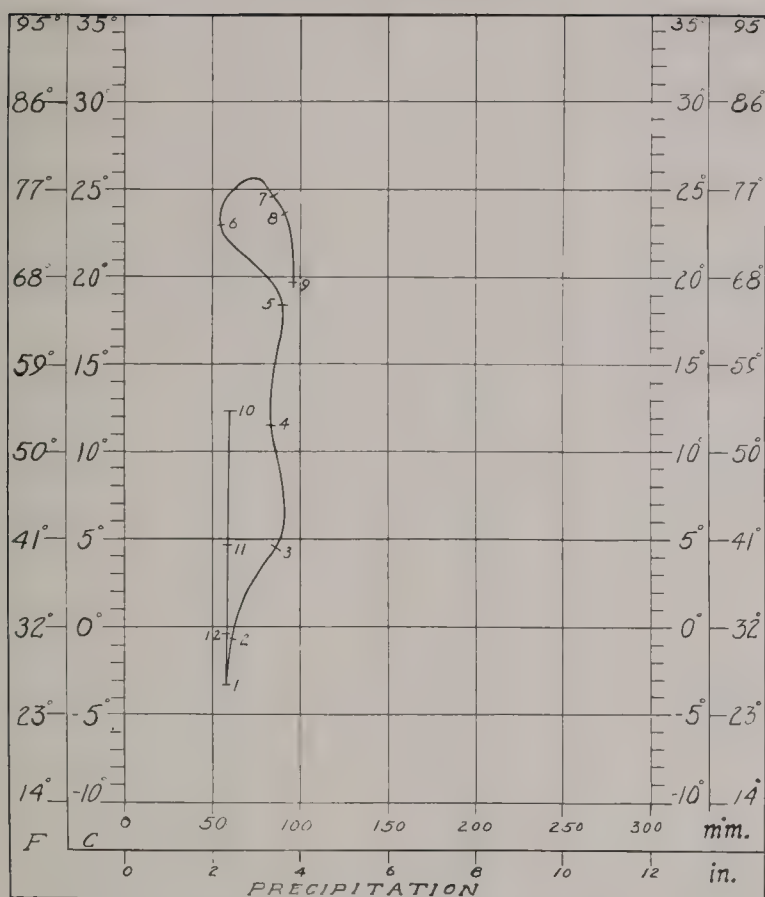


Fig. 31. Hythergraph showing average conditions in years in which damage to crops was severe.

Fig. 31 shows the mean march of local temperature and rainfall from month to month, beginning with October (10) and ending with September (9), in years of severe damage to crops in Illinois. Here it is noteworthy that May (5) is relatively dry and warm, the rainfall averaging approximately 3.5 inches, or 83 mm., and the temperature averaging approximately 18° C. June (6) is still drier, with only a little more than 2 inches rainfall, so that the line swings to the right in July and August.

In Fig. 32, which represents average local conditions in years of no damage by chinch bugs, the rainfall is seen to be heavier in spring than in summer. The mean for May is 4.7 inches, or 117 mm., and for

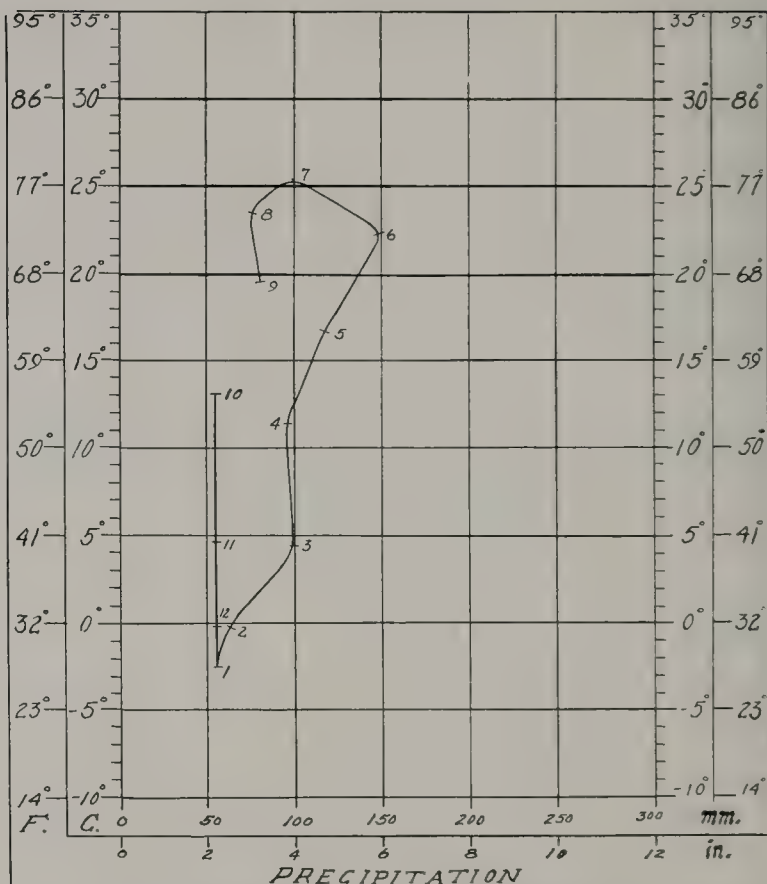


Fig. 32. Hythergraph showing average conditions in years in which no damage was done to crops.

June it is almost 6 inches, or almost 150 mm. The trend in July and August is toward the left, the reverse of the trend in Fig. 31. The temperature in May averages about 17°C.

Numerous exceptions to these general rules for May and June may be noted in Figs. 26-30. Evidently the amount of rainfall in May and June is not the only factor in the abundance of the bugs. Temperature also must be taken into account, and some allowance should be made for the relative vigor of the bugs. For further light on this problem, periods of waxing abundance may be compared with periods of waning abundance, as follows: Fig. 33 is a generalized picture of conditions favorable to development of chinch bugs in the following year. This

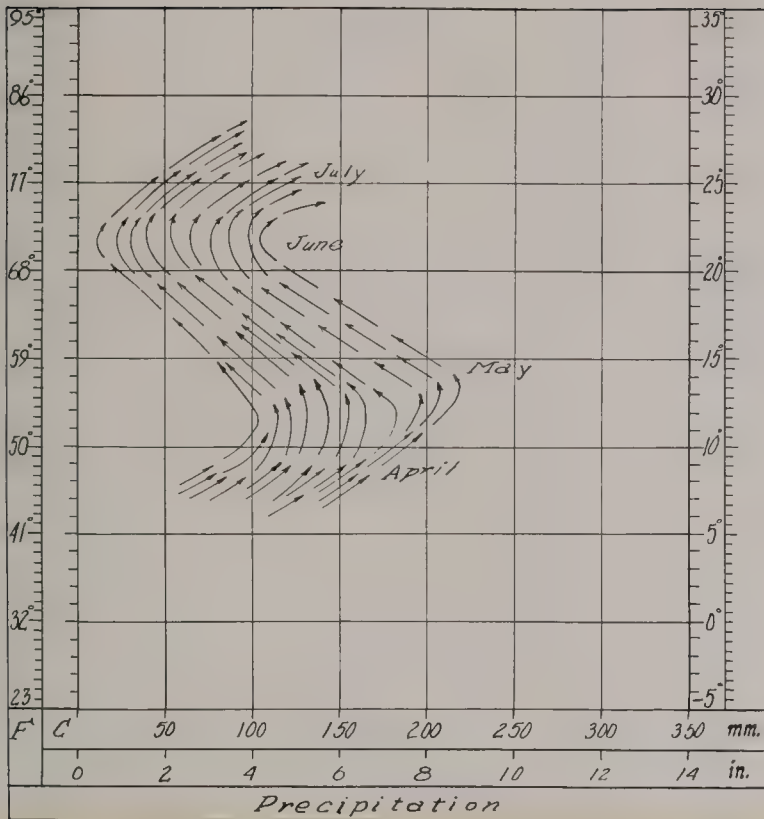


Fig. 33. Hythergraph showing average conditions in years of abundant bugs and severe damage. The diagram is formed from data on such years when preceded by one or more years of no damage.

is based on a detailed analysis of 90 cases in which a scarce year was followed by an abundant year. The mean monthly rainfall in May ranges from 4 to 8 inches, or from 100 to 200 mm., but June is decidedly drier than May, and the trend after June is toward the right-hand side of the figure. It is evident that there is considerable truth in the contention that two dry years are prerequisite to a chinch bug outbreak. Indeed, the June of the year preceding an outbreak is usually drier than the June of the outbreak.

Fig. 34 represents the results of an analysis of 96 cases in which a scarce year was preceded by an abundant year. Here the rainfall is relatively great in May and June, and the general trend is the reverse of that found in Fig. 33. Decline of bugs in years with little rainfall in May and June was no doubt due to other adverse factors.

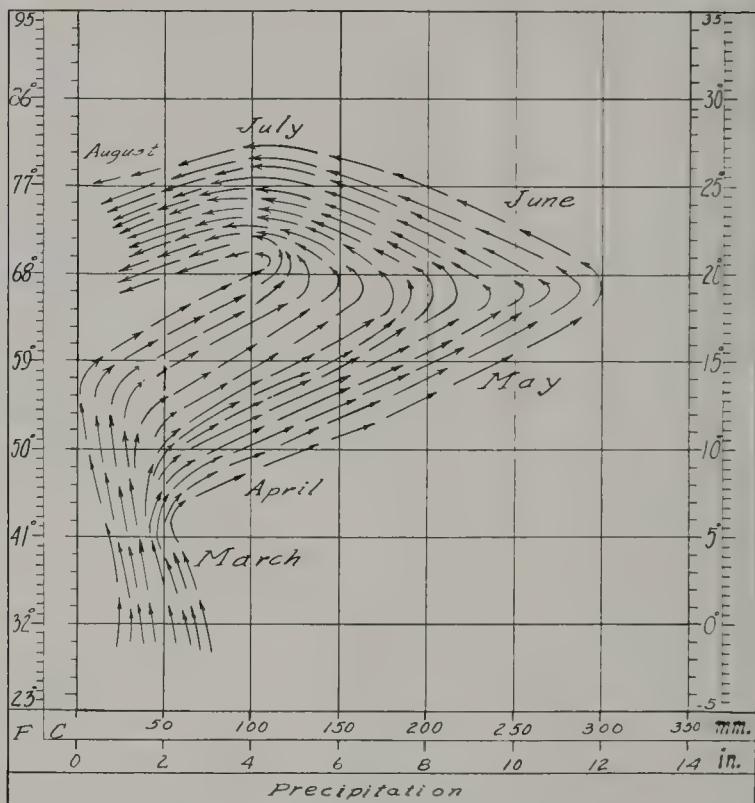


Fig. 34. Hythergraph showing average conditions in years of no damage that were preceded by years of severe damage.

Only a few exceptions to the usual seasonal trend were found. In 1919, after a year of no crop damage, the bugs became very abundant and caused severe damage in spite of the comparatively large amount of rainfall in May. The rainfall was distributed over 16 days of that month, and at many stations in the infested area it ranged from 5 to 9 inches, but it may have missed the critical period of the bugs very generally. Other examples in which heavy spring rains failed to stop the progress of the bugs may be seen in the maps for 1921 and 1924 (Figs. 26 and 29), in which it appears that the rainfall was sometimes greater in the counties where the damage was severe than in the counties where it was moderate or slight.

There is no evidence that low temperatures or other conditions in the winter months have material effects on the abundance of chinch bugs in the following season. At least, winter temperatures as repre-

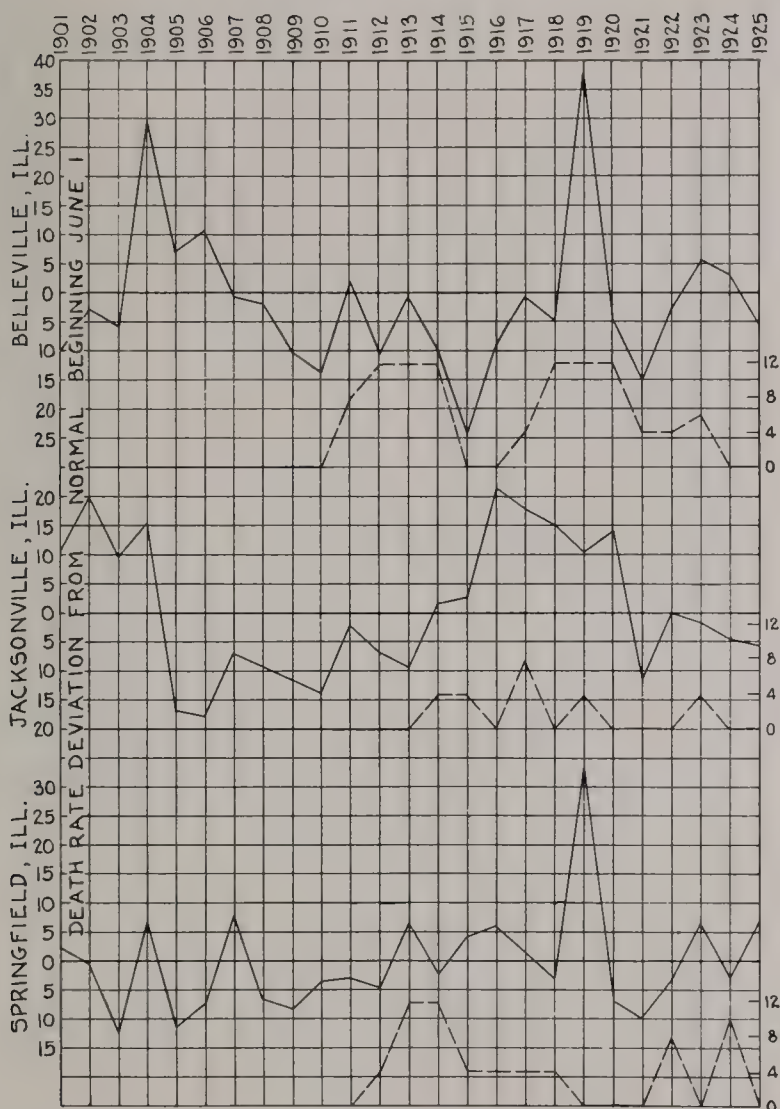


Fig. 35. Graphs suggesting correlation between human death rate in Belleville, Jacksonville, and Springfield, 1901-1925, and chinch bug damage to crops in each locality during a part of this period. The solid lines indicate deviation from the normal death rate for each city and refer to the scale of percentages at the left. The broken lines, indicating degrees of damage to crops in the county in which each city is located, refer to the scale at the right, which consists of relative values assigned to the several degrees of reported damage, as follows: 4 = slight; 8 = moderate; 12 = severe. The bugs were very scarce in the first decade.

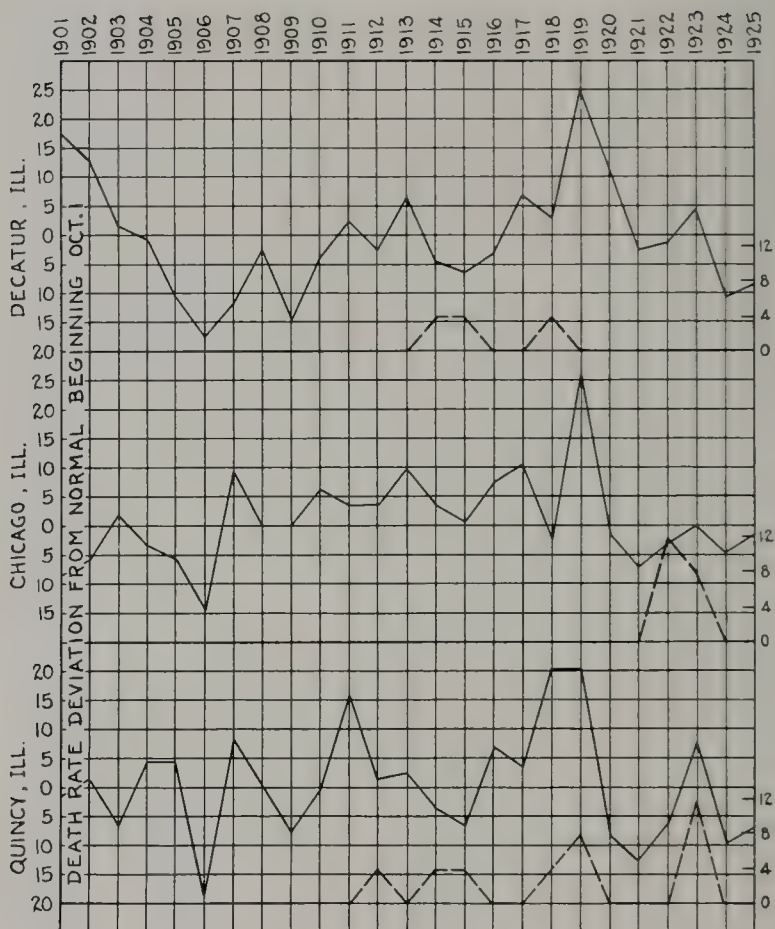


Fig. 36. Graphs suggesting correlation between human death rate in Decatur, Chicago, and Quincy, 1901-1925, and chinch bug damage to crops in each locality during a part of this period. For explanation see Fig. 35. The bugs were very scarce in Macon County and Adams County during the first decade and in Cook County during the first two decades.

sented by monthly means do not appear to affect abundance. This was checked for Virginia, Wisconsin, and Ohio as well as Illinois. Bugs have done severe damage following unusually cold winters in Beloit, Wisconsin, and unusually warm winters in Virginia, and the opposite extreme in both places.

A great deal of attention was given to examining old records with a view to learning more about the way in which weather controls the chinch bugs. This, however, proved not to be very profitable. The

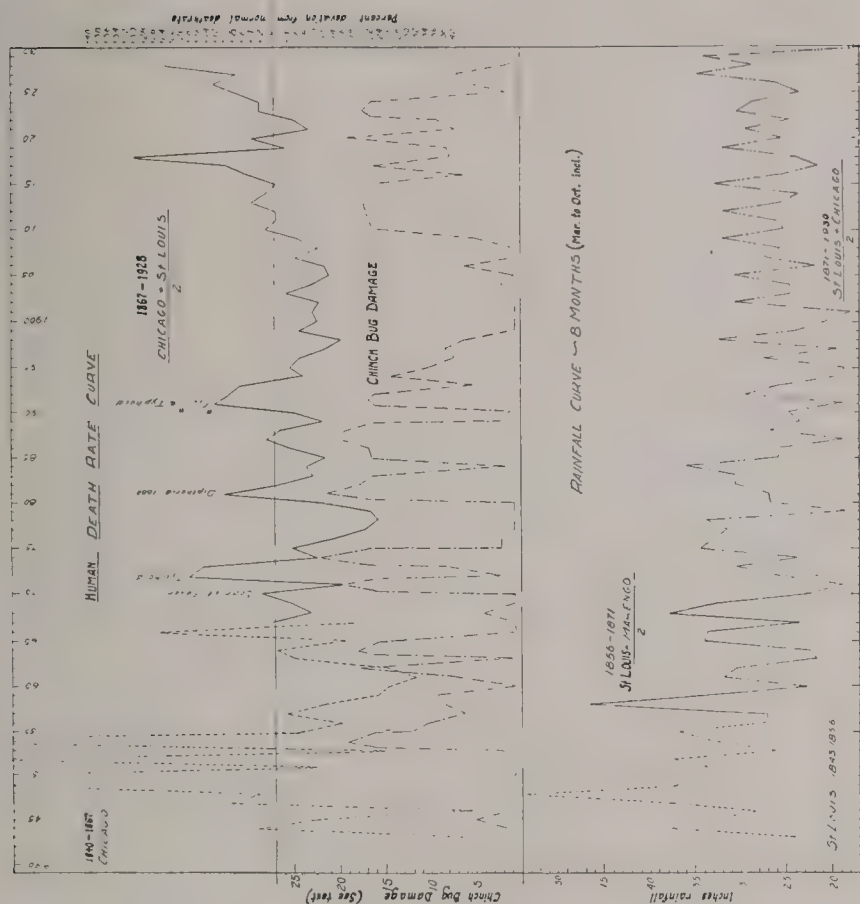


Fig. 37. Graphs showing variations in human death rate and rainfall in Chicago and St. Louis, and in chinch bug damage throughout Illinois, 1840-1930. The death rate in Chicago alone from 1840 to 1867 (dotted part of first curve) and in Chicago and St. Louis (averaged) from 1867 to 1928 (solid line) is indicated with reference to the scale at the right. The chinch bug damage is represented by the dash-dot line with reference to the scale at the left, the construction of which is explained in the text. The lower broken line indicates the rainfall in St. Louis alone from 1843-1856, the average for St. Louis and Mathero from 1856 to 1871, and the average for St. Louis and Chicago from 1871-1930.

chinch bugs are of such a character that they can be killed off in numbers by the rain of a single night, and it is impossible to know the distribution of rain from the older records, as the rain from day to day is not given. After gathering a large amount of information from literature, from colleagues in other states, and from the records of the State Entomologist's Office, it was decided that further pursuit of this line of work was not advisable. Any further light thrown on this aspect of the chinch bug problem probably must come mainly from the detailed and whole-hearted efforts of investigators in a position to devote careful attention to the numbers of the bugs and to their relations to conditions as they occur in the field, and from the correlation of such findings with careful physiological studies. Our difficulty lies in the fact that except for a limited period we have no knowledge of the abundance of bugs in the autumn and again in the spring, or in early spring and again at the close of the crop season. In cases where data of this kind have been obtained the tendency is to confirm the findings of the writer and the older investigators. The exceptions usually indicate that the distribution and character of the rainfall is more important than its total amount in a given period.

The writer accidentally discovered some evidence of apparent correlations between death rate in man and the abundance of chinch bugs. In some localities the chinch bug damage is great in years in which the human death rate is high. Analyses of the available data by simple comparison were carried out for a number of cities and over a number of years, with results as shown in Figs. 35 and 36 for six localities from 1900 to 1925. A more comprehensive comparison is afforded in Fig. 37, which represents the reported chinch bug damage throughout Illinois since 1840 in comparison with rainfall and death rate in two cities, Chicago, and St. Louis. The crop damage in each year was estimated by counties; each county with severe damage was assigned a value of 3, moderate damage 2, and slight damage 1; and then the sum of these assigned values for all the counties in the state was divided by 2 in order to obtain the rating for the year, and in that way the scale at the left of Fig. 37 was constructed. The lack of vital statistics for St. Louis and of weather records for Chicago in the earlier years made it impossible to obtain averages throughout the period covered by the records of the insect. It will be noted, however, that there is fairly close correlation between the periods of high death rate and great chinch bug abundance. The death rate usually rises in dry periods and falls in wet periods, and the chinch bug damage frequently follows these fluctuations rather closely, sometimes coinciding with them and sometimes lagging one year. In this connection it is

worth repeating that variation in the vigor and fecundity of the bugs themselves is postulated as a factor not noted hitherto.

CONCLUSION

The chinch bug is a very sensitive insect. The immeasurable factors, such as quality of food, presence of aphids or other insects, variations in the soil or in the food plants, and changes in the vigor of the bugs, interfered with the success of the cultures and so far overshadowed the experimental differences in temperature, humidity, and light as partly to vitiate the results of experiments designed to determine the effects of these factors. This same sensitivity of the insect also makes it difficult to draw conclusions from the data of field observers. While it is evident that young chinch bugs may be killed by rain, still a large total rainfall in a particular month does not always result in their destruction throughout an area, for the rain may fall too slowly or may be too localized in small showers. Field observations of outbreaks have not been exact, and in the absence of quantitative observations on the abundance of the bugs, refinement of conclusions is not practicable. The results of the present study, however, may be summarized as follows:

1. Individual variation in the lengths of instars and life histories is very great, probably on account of the sensitivity of the bugs.

2. Low humidity affects the first instar strikingly and each succeeding stage to a lesser degree.

3. The relations of the rate of development to temperature and humidity are expressible in developmental units, and for each stage an equal-velocity chart is presented, similar to those used by the author in his study of the codling moth.

4. The success of the bugs in a long series of cultures shows that their vigor varies from year to year. The bugs were very strong in 1919 and 1925, producing three or four generations in each of these years. They were weakest in 1921. This does not, however, correspond with the severest outbreaks of the bugs in the state. It does indicate the possible importance of internal factors not directly correlated with the immediate surrounding conditions but determined earlier. It is necessary to consider *unbalance* in the bugs themselves as well as the *unbalance* in the system of nature of which they are a part.

5. In the early history of the outbreaks in Illinois there was a striking correlation between human death rate and chinch bug damage. With better developed agriculture and improved sanitary conditions this relation has become less striking.

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INDEX

Indexes and tabulations of species, with the exception of plankton species tables in articles IV and V, are not duplicated in this index to the volume. The reader is referred to page 99 for an index to names of fish species, page 113 for a tabulation of Illinois birds, page 389 for an index of plant lice hosts and page 439 for an index of plant lice species.

A

- Accessory radial thickening—see New terms
- Actinastrum hantzschii* 474, 480, 483, 486
- Adams county 542
- Algae 453, 454, 455, 474, 475, 480, 483, 486
- Alona* sp. 451, 466
- Ambrosia trifida* 13
- Anabaena*
 - circinalis* 460
 - planktonica* 454, 460
 - spiroides* 454, 460
- Ankistrodesmus falcatus* 461, 480, 486
- Annureopsis fissa* 485
- Aphanizomenon flos-aquae* 460
- Aphanocapsa*
 - sp. 483
 - spp. 460
- Arcella vulgaris* 456, 457, 462, 479, 481, 484
- Asplanchna* 474
 - sieboldii* 464
 - sp. 479, 482, 485

B

- Bacillariaceae 460
- Bald eagle 109
- Beardstown, Illinois 470
- Belleville, Illinois 541
- Bermuda islands 60
- Bidens*
 - cernua* 13
 - frondosa* 13
 - spp. 13
- Bird waves 105, 112
- Blissus leucopterus*—see Chinch bug
- Boneyard 52, 57
- Bosmina*
 - longirostris* 451, 453, 466, 473, 474, 480, 482
 - obtusirostris* 466

- Botryococcus sudeticus* 461
- Brachionus* 454, 458, 473, 474, 477
 - angularis* 457, 466, 474, 475, 479, 482, 485
 - budapestinensis* 479, 482, 485
 - calyciflorus* 466, 479, 482, 485
 - capsuliflorus* 479, 482, 485
 - patulus* 454, 456, 465, 479, 482

C

- Callitriche* sp. 13
- Cass county 470
- Catostomidae 18
- Centropyxis aculeata* 479, 481, 484
- Cephalanthus occidentalis* 13
- Ceratium hirundinella* 455, 464, 473, 474, 479, 481, 484
- Ceriodaphnia lacustris* 466
- Champaign, Illinois 52
- Champaign county
 - altitude 5
 - area 5
 - drainage area 8, 16
 - basins 6
 - fish
 - abundance 39, 41, 48, 50
 - ambient medium 39
 - analytical keys 18
 - collections 14, 16
 - diseases 39
 - distribution 41, 60
 - environmental factors 58
 - growing season 12
 - migration 60
 - morphological adaptations 58
 - parasites 39
 - revised names 17
 - species 17
 - type habitats 34
 - intermorainal tracts 6
 - marsh 7
 - moraine 5
 - outcrops 6

Champaign county—cont'd

- soils 7
- streams 7, 469
- topography 5, 6
- water table 7
- weather records 7

Chandlerville, Illinois 470, 471, 472, 473, 474, 476, 478

Chicago, Illinois 542, 543, 544

Chinch bug

- apparatus 488, 522
- correlation with human death rate 541, 542, 543, 544
- cultures 515, 516, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530
- developmental total 506, 507, 508, 509, 510, 511, 512, 513, 514
- units 503, 506, 507, 508, 509, 510, 511, 512, 513, 514
- distribution 531
- fecundity 534
- food 490, 509, 515
- hibernating 515
- hythergraphs 536, 537, 538, 539, 540
- instars 489, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502
- life history 489
- moisture 489, 490, 498, 508
- outbreaks 531, 532, 533, 534, 535, 536
- pre-oviposition period 513, 514
- sex 517
- stock 520
- velocity of development 504, 511, 512
- ventilation 489, 490
- vitality 534

Chironomid 457

Chlamydomonas spp. 464, 484

Chlorophyceae 461

Christian county 520, 532, 535

Chroococcus spp. 460

Chydorus sphaericus 451, 467, 480

Cladocera 453, 466, 480, 482, 485

Cladophora

- crispata 13
- glomerata 13, 53

Closteriopsis longissima 461

Closterium

- acerosum 451, 462, 486
- acutum 480, 483, 486
- gracile 462
- moniliferum 462, 483, 486

Closterium—cont'd

- strigosum 462
- subtruncatum 462
- venus 462

Codling moth 487, 488, 489, 498, 507, 508, 513, 536

Codonella cratera 453, 455, 464, 473, 474, 475, 476, 479, 481, 484

Coelastrum

- microporum 461, 480, 483, 486
- reticulatum 461

Coelosphaerium

- kuetzingianum 451, 460
- naegelianum 454, 460

Conochiloides

- dossuarius 451, 464
- natans 482

Conochilus hippocrepis 464

Cook county 542

Copepoda 451, 453, 457, 467, 480, 483, 486

Copper slough 57

Corethra 467

Cosmarium

- botrytis 462
- depressum 456, 462
- quinarium 462
- sp. 486

Crane oil separators 489

Crucigenia

- irregularis 461

Crystal lake 107, 108

- park 52

Cyanophyceae 460

Cyclops

- bicuspidatus 451, 453, 455, 467, 473, 474, 477, 480, 483
- leuckarti 467
- serrulatus 457
- viridis 453, 455, 457, 467, 480, 486

Cyclotella spp. 486

D

Daphnia longispina 466, 473, 474, 480, 482, 485

Decatur Illinois 470, 471, 473, 474, 476, 477, 478

death rate 542

lake 471, 472, 473, 474, 475

sewage disposal plant 471, 472, 474, 475

Dianathera americana 13
Diaphanosoma brachyurum 451, 466,
 474, 480, 482, 485
Diaptomus
 mississippiensis 451, 455, 467
 siciloides 473, 483, 486
Dictyosphaerium pulchellum 461
Diffugia
 acuminata 457, 463, 481, 484
 globulosa 451, 463
 lobostoma 456, 463, 474, 475, 479, 481,
 484
 urceolata 451, 462
Dinobryon sertularia 451, 464, 479, 481
Distylla spinifera 485
Diurella
 stylata 465, 482, 485
 tigris 465
Dorr separators 475
Duck hawk 109

E

Echo river, Kentucky 449
Elodea 10
 canadensis 13, 53, 55
Embarrass (Ambraw) river 7, 14, 16,
 50, 60
Epistylis 55
Equisetum hiemale 13
Euchlanis deflexa 465
Eudorina elegans 451, 464, 474, 479,
 481, 484
Euglena
 acus 463, 479
 acutissima 481, 484
 oxyuris 463, 479, 481, 484
 sanguinea 455, 456
 sp. 479
 spirogyra 456
 tripteris 463
 viridis 456, 463, 474, 479, 481, 484

F

Fayette county 535
Filinia
 longiseta 457, 465, 479, 482
 (*Triarthra*) 474
Fisher, Illinois 469
Fissidens Julianus 13
Foosland, Illinois 469
Forestry, the 106, 107

Fragilaria 453
Frison, T. H. 54, 57

G

Gibson City 57
Glaciers
 early Wisconsin 6
 Illinoian 6
Glenodinium sp. 484
Golden eagle 109
Gonium pectorale 481, 484
Gyrosigma
 sp. 483
 spp. 480, 486

H

Harristown, Illinois 471, 472, 473, 474,
 476, 478
Homer dam 56, 66
Hydrogen ion 452, 473

I

Illinois
 fish commission 65
 -Mississippi canal feeder 61
 river 52, 455, 469
 state water survey 452
Illiopolis, Illinois 471, 472, 473, 474,
 478
Insecta 453, 467
Iroquois river 50

J

Jacksonville, Illinois 541
Juncus spp. 13
Jussiaea diffusa 13

K

Kaskaskia (Okaw) river 7, 10, 14, 16,
 50, 67, 469
Keratella 473
 cochlearis 451, 453, 457, 466, 474, 475,
 479, 482, 485
Kunz, Jakob 526

L

Lagerheimia sp. 461
Lecane
 ohioensis 465
 spinifera 479
 ungulata 451, 465
Lemna minor 13
Lepadella acuminata 455, 456, 465

Limnodrilus hofmeisteri 55
 Little blue heron 109
 Livingston porous cup atmometers 489
Lysigonium 453, 454
 granulatum 460, 474, 477, 480, 483,
 486
 varians 451

M

McLean county 469
 Macbeth illuminometer 525
 Mackinaw river 50
 Macon county 470, 520, 542
 Mahomet, Illinois 469, 471, 472, 473,
 474, 475
 Mallomonas
 caudata 463
 producta 464
 Mammoth cave 449
 Marion county 535
 Markus, H. C. 40
 Mason county 470
 Menard county 470
Micrasterias americana 451, 462
Micratinium pusillum 486
Mycrocystis
 aeruginosa 460
 flos-aquae 460
 incerta 460
 Mills, R. W. 65
 Mississippi
 river 476
 state 454
Moina affinis 466, 473, 474, 480, 482
Monostyla
 bullae 465
 lunaris 465
 quadridentata 455, 456, 465
 Monticello, Illinois 470, 471, 472, 473,
 474, 475, 478
Myriophyllum 10
 heterophyllum 13

N

Nannoplankton 472
Navicula spp. 460
Nematoda 453, 457
Netrium
 digitus 451, 462
 New terms
 accessory radial thickening 129
 Norton, E. A. 50

Notholca longispina 451, 466
Nymphaea advena 13

O

Oscillatoria sp. 457
Ostracoda 453, 467

P

Pandorina morum 464, 474, 479, 481,
 484
Pedalia 474
 mira 466, 480, 482
Pediastrum 454
 duplex 461, 480, 483, 486
 simplex 483, 486
 tetras 461
Peridinium
 cinctum 453, 455, 464
 sp. 456
 Petersburg, Illinois 470, 471, 472, 473,
 474, 475, 478
Phacus
 acuminata 463, 484
 longicaudus 463, 479, 481, 484
 pleuronectes 481, 484
 Photo-electric cell 525, 526
 Phytoplanktonts 454
 Piatt county 61, 65, 470
 Planktonts 452, 458
Platydorina caudata 481, 484
Pleodorina
 californica 464
 illinoisensis 456, 464, 474, 479, 481,
 484
Pleurotaenium sp. 451, 462
Pleuroxus
 hamulatus 466
 sp. 467
 trigonella 467
 Pollution 470
Polyarthra 473, 474
 trigla 451, 453, 456, 465, 474, 476,
 479, 482, 485
Polygonum Hydropiper 13
Pompholyx complanata 465
Potamogeton
 americanus 13
 heterophyllum 13
 pusillus 13, 53
 zosterifolius 13
 Protozoa 453, 455, 462, 479, 481, 484

Psychoda alternata 55
 Pulaski county 450

Q

Quincy, Illinois 542

R

Radicula Nasturtium-aquaticum 13
 Rantoul, Illinois 57
Ranunculus aquatilis 13
 Reelfoot lake, Tenn. 454
 Richardson, R. E. 17, 46, 55
 Riverton, Illinois 470, 471, 472, 473,
 475, 478
 Rock river 42, 46, 60, 61, 62, 455, 469
Rotaria neptunia 451, 464, 479, 485
Rotatoria 453, 464, 479, 481, 485
Rotifer tardus 55
Rumex
 crispus 13
 verticillatus 13

S

Sagittaria heterophylla 13
 St. Joseph, Illinois 54
 St. Louis, Missouri, 543, 544
Salix spp. 13
 Salt creek 470, 474
 Salt fork 5, 7, 9, 11, 13, 14, 16, 48, 49,
 50, 52, 55, 56, 58, 62, 63, 65, 66,
 67, 107
 east branch 7, 48, 50, 54, 56, 57, 63
 west branch 52, 54, 55, 56, 57, 65
 Sandhill crane 109
 Sangamon
 county 470, 520
 river 7, 9, 11, 13, 14, 16, 42, 50, 61,
 62, 63, 65, 66, 67, 469, 476
 Sargasso sea 60
Scapholeberis mucronata 466, 480
Scenedesmus 454
 arcuatus 461
 bijuga 461
 dimorphus 461, 480, 483, 486
 quadricauda 461, 480, 483, 486
Schizocerca diversicornis 466, 482
Schroederia setigera 486
Scirpis
 atrovirens 13
 fluvialis 13
 validus 13

Sedgwick-Rafter slide 452, 472
Selenastrum

gracile 486
Semipalmated sandpiper 109
 Shawnee cave, Indiana 449
 Smith, Frank 65
 Snowy owl 109
 Soil survey 50
 South fork 470, 472, 474, 475
Sparganium sp. 13
Sphaerotilus natans 475, 476
Sphinctocystis librilis 483, 486
Spiradela polyrhiza 13
Spirogyra
 sp. 451
 spp. 456, 462
Spondylosium planum 462
 Spoon river 48
 Springfield, Illinois 470, 471, 472, 473,
 475, 477, 478, 541
 State entomologist's office 544
Staurostrum
 cuspidatum 462
 gracile 462
 Sterling, Illinois 42
Strombidium sp. 464
 Sudan grass 494, 515, 529
Surirella robusta 457, 460, 483, 486
Synchaeta 454, 473, 474
 pectinata 479, 482, 485
 stylata 485
Synedra
 tenuissima 453, 460, 480, 483, 486
 ulna 451, 453, 460

T

Tehon, L. R. 13
Testudinella patina 465
Tetraedron
 gracile 460
 lobulatum 460
 trigonum 460
Thiotrix 55
Tintinnidium fluviatile 479, 481, 484
Trachelomonas 455
 armata 463
 ensifera 456, 463, 474, 479, 481, 484
 hispida 456, 463, 479, 481, 484
 magdaleniana 455, 463
 similis 463
 tambowika 463

Trachelomonas—cont'd

volvocina 453, 455, 456, 463, 474, 479,
481, 484

Treubaria crassispina 461

Trichocerca

gracilis 482, 485

multicrinus 451, 454, 458, 465

pusilla 465, 482, 485

(Rattulus) 474

stylata 485

Trichotria tetractis 485

Tubifex tubifex 55

Typha latifolia 13

U

Ulothrix sp. 462

Urbana, Illinois 52, 66

fish hatchery 54, 65

V

Van Cleave, H. J. 40

Vermilion river 50, 107

big vermilion 50

little vermilion 7, 14, 16, 50

middle fork 7, 11, 13, 14, 63, 66, 67

Volvox globator 451

W

Wabash river 50

Washington county 532, 535

Watercress 10

Water smartweed 10

Wetaug, Illinois 450, 457

Whistling swan 109

Wild Cat creek, Indiana 68

Y

Yuasa, H. 491

ERRATA

Page 99, column 1, line 1, omit $3\frac{1}{4}$

Page 155, line 8, omit *The wings of the holotype* . . . nymphs and one pupa.

Page 178, couplet 32, for *Hind tarsi*, both lines, read *Hind tibiae*

Page 196, line 9, omit *Sexual forms and mating pairs* . . . October 22, 1930.

Page 228, line 19, for LINNAEUS read (LINNAEUS)

Page 306, line 24, insert and read *under* following (1911b)

Page 340, line 23, before *Setaria viridis* insert and read *Sedum artissimum*

Page 405, line second from bottom, prefix author's name, DAVIDSON, J.

Page 420, line 3, Fig. 75, for *Paducia antennatum* (Patch) read *Cinara laricis* (Hartig)

Page 426, Fig. 166, before *apterous* insert and read *cauda*,

